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ABSTRACT

To identify and evaluate the implications of potential communications and computer technology alternatives to urban transportation, an extensive research study was made of telecommuting--bringing workers together by communication instead of physically. An attempt was made to formulate practical statements on telecommuting network design, policies to promote telecommuting use and to regulate development. Energy, land use, transportation and labor policies were considered. Research focused on an insurance company as a typical information-industry organization that was promising for telecommuting. Technological requirements were specified along with organizational configurations and cost-benefit functions. Employee motivation was also surveyed. The report concluded that telecommuting was an economically feasible alternative to commuting, that employees were motivated by it, and that its adoptions could have a significant impact on energy consumption, transportation patterns, and urban development. (SK)

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TELECOMMUNICATIONS— TRANSPORTATION TRADEOFFS

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AN INTERDISCIPLINARY
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OF THE
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FINAL REPORT
DEVELOPMENT OF POLICY
ON THE
TELECOMMUNICATIONS-TRANSPORTATION TRADEOFF

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Abstract

ABSTRACT

This report presents the findings of research conducted from 1 July, 1973, to 31 December, 1974, by an interdisciplinary team at the University of Southern California. The work was performed with the partial support of the National Science Foundation program of Research Applied to National Needs under grant number GI 39019.

A. Objective

The purpose of the research was to identify and evaluate the implications of potential communications and computer technology alternatives to urban transportation, particularly the commute to work (telecommuting). The research was directed toward the formulation of practical statements on telecommuting network design, policies to promote the use of telecommunications among information industries, and policies to regulate the development of such networks. Policy questions on the local, state, regional and national level were considered. Energy, land use, transportation, and labor policies were considered in addition to the telecommunications policy questions.

B. Scope

The interdisciplinary team defined three primary aspects of the telecommunications-transportation tradeoff. First, such a tradeoff must be economically advantageous. From this, the premise was advanced that any extensive substitution would be predicated on the existence of economic incentives to individual businesses to engage in the substitution. Second, the technological base for the substitution must exist. The technology must be sufficiently advanced to meet the work-related communications requirements of the commuter. Third, the substitution must be effective. Workers must be able to perform in a telecommuting environment and have the motivation to do so.

The most promising area for the occurrence of telecommuting is the information industry. The USC team selected a typical information industry organization - an insurance company - to act as the focus for the research. Organizational configurations were defined, communications requirements were assessed, employee locations and commuting costs were determined, technological requirements were specified, a telecommunications network model was designed, and cost/benefit studies were performed. To assess the motivational aspects of telecommuting, a series of surveys was made of participants in the USC and Stanford Interactive Instructional Television Systems. An extensive literature search for related research was also performed and a computerized bibliography was compiled.

C. Summary of Results

- On the basis of the research, the USC team concluded that:
- a) telecommuting can represent an economically attractive

alternative to commuting for both the commuter and for individual businesses; b) audio bandwidth telecommunications channels are generally sufficient for most telecommuting purposes; c) almost all of the routine operations of the company studied can be performed using off-the-shelf computer, terminal, and telecommunications technology, although some improvements in teleconferencing software are required before extensive management level telecommuting will occur; d) workers can perform work effectively using telecommunications and have a high motivation to do so; e) if instituted on a broad scale, telecommuting can have significant impact on national energy consumption, transportation patterns and urban development.

PROLOGUE

This report summarizes the research performed during FY 73 by the University of Southern California under grant number GI 39019 (National Science Foundation, Research Applied to National Needs Program). For further information regarding this report, please call (213) 746-7464 or write to the Office of Interdisciplinary Program Development (OIPD), ADM 259, University of Southern California, University Park, Los Angeles, CA 90007.

Mr. Jack Nilles, Director of Interdisciplinary Program Development, was the Principal Investigator for the project; he directed and coordinated the research from its inception. Dr. Frederic R. Carlson of the School of Engineering, Dr. Paul Gray of the Graduate School of Business Administration, and Dr. Gerhard Hanneman of the Annenberg School of Communications at USC were Co-Principal Investigators. Dr. Carlson directed research on the technological aspects of the telecommunications-transportation tradeoff; his work included design of a model telecommunications network, scenario formulation, and cost calculations for various technological alternatives. Dr. Gray was responsible for the identification and analysis of the economic aspects of the tradeoff. Under his direction, case studies were performed of a large insurance company and the banking industry in general. The study of the

insurance company included the collection of data on the company's organization and definition of the information flow patterns between various sectors of the company. Dr. Hanneman coordinated research on the motivational aspects of the tradeoff. In particular, this involved the design, administration and analysis of a series of surveys of various populations to determine their perception of a telecommunications-transportation tradeoff. Also under Dr. Hanneman's direction, the background literature gathered by the research team was abstracted and placed on computer file. Dr. Jack Munushian, Chairman of the Computer Science Program at USC, participated in the project throughout and provided valuable advice and information regarding the USC Interactive Instructional Television System and related systems, and current technology in the area. His counsel is greatly appreciated.

Many individuals participated in the conduct of the research and the preparation of this report. The research assistants from the School of Engineering, James Cochran and Lorain del'Osso, participated in the definition of the technological and network requirements. David Lopez, from the Graduate School of Business Administration, worked extensively on definition of the insurance company's organizational configuration, evaluation of the company's communication requirements, and compilation of employee transportation data. Thomas Dubanoski, Maissa Ibrahim and Marie Jurusz participated in the survey design, administered the survey and analyzed the survey data. Maggie Cross, aided by Leslie Rugg,

undertook the onerous task of compiling and primary editing of this report.

Some remarks on notation are in order. This report has been compiled and edited by means of an IBM 370/158 computer, operating in a time-sharing mode, with a printing, interactive terminal. Editing, error correction, margin justification, pagination, and similar tasks have been performed through this interaction. Use of the terminal has imposed one limitation: exponents are printed out as $10 \exp x$, rather than 10^x . Footnote references are enclosed in brackets [] and are listed separately for each chapter.

CHAPTER I. BACKGROUND

A. INTRODUCTION

Until recently in the history of man, communication over any distance was dependent upon transportation. i.e., one had to physically travel to another place to communicate with another individual or to transact business. To a large degree, the availability of various types of transportation determined the location, growth and configuration of cities. This was the case in the 17th, 18th and 19th centuries for most American cities; their locations at the conjunction of waterways or near natural harbors satisfied the transportation and communication needs of the inhabitants. Railroads and the telegraph permitted the growth of cities on the Great Plains at the conjunction of or along major overland trade routes. By the end of the 19th century, a new phenomenon - urban sprawl - was developing as a consequence of the introduction of the electric streetcar. The automobile aggravated and institutionalized the growth of suburbia.

Today, suburbia continues to push outward into rural areas while the city cores become more business oriented. R.C. Harkness defined the resulting configuration as a series of concentric zones (Figure I-1) [I-1]. In the center is the central business district, consisting of offices and retail stores. This is surrounded by a deteriorating zone of railroad terminals, older manufacturing plants, and warehouses. The next zone comprises older, high-density residential areas that are declining into

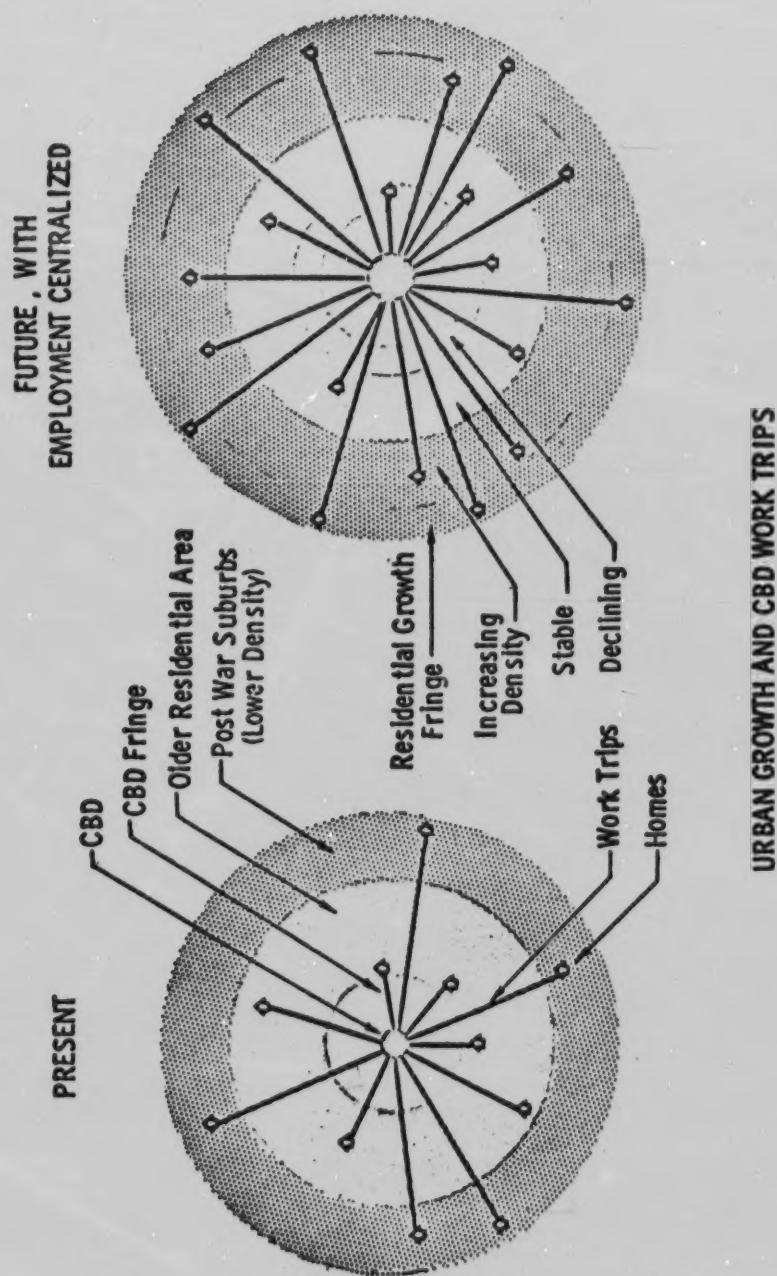


FIGURE I-1. Present and Projected Urban Growth and CBD Work Trips.

(Source: Harkness, R.C., "Communications Substitutes for Travel: A Preliminary Assessment of their Potential for Reducing Urban Transportation Costs by Altering Office Location Patterns" (Ann Arbor, Michigan: University Microfilms, 1973).

slums in many cities. The remaining zones represent newer housing developments, usually of single-family dwellings, that have been built since World War II and the spread of the private automobile. Every major city in the United States has one or more central business districts (CBD's) strung together with freeways.

A recent Department of Transportation report entitled "Suburbanization and Its Implications for Urban Transportation Systems" noted that 46 percent of the metropolitan population lives in the urban fringe and that the recent trend is toward a mixture of high and low density areas in the fringe. [I-2] Scattered throughout the urban fringe of most metropolitan areas are high density "activity clusters," with both a high density CBD and high density concentrations scattered throughout the metropolitan area surrounded by low density residential areas. As the metropolitan areas continue to expand, we are faced with the new phenomenon of megalopoli, which extend over vast areas of land and which present unique transportation problems. The inherently low population density of this urban sprawl is in itself a major cause of extensive transportation usage. The fact that the average metropolitan worker lives at some distance from his work exacerbates the problem.

B. URBAN TRANSPORTATION.

The increasingly ubiquitous private automobile dominates urban transportation and has major impacts on the structure of urban life. In 1970, 92 million automobiles were registered in the United States, approximately 10 for every 23 people [I-3].

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Approximately 63 million of these automobiles (representing the 68.2% of the population that lives in urban areas) [I-4] are in metropolitan areas. Victor Gruen, a noted urban planner, estimates that the space required for private automobiles in a typical city is more than six times as great as the living space required for the inhabitants. [I-5] By 1969, motor vehicles accounted for 77% (by weight) of the more than 87 million tons of carbon monoxide emitted annually in the United States, 50% of the 25 million tons of hydrocarbons, and 33% of the 18 million tons of nitrogen oxides. [I-6] In urban areas, automobiles contribute an even higher percentage of pollutants, typically producing more than 90% of the carbon monoxide and up to 75% of the hydrocarbons. [I-7]

The energy costs of private automobiles are high, both in terms of effectiveness when compared with other modes of urban transportation and in terms of the total energy used in the United States. Estimates of total energy costs for transportation range from 23.8% to 25.2% of the gross national energy use. [I-8, I-9] This proportion of gross national energy use is expected to remain relatively constant for the next few years. For our calculations, we assumed a value of 25% for the percentage of gross national energy used for transportation. This value can be expressed as 17×10^{15} Btu's (British Thermal Units) of energy used in 1971 for transportation with an expected 19×10^{15} Btu's in 1975.

Automobile transportation constitutes 42% of all transportation use, according to Hirst. [I-10] Urban automobile

use accounted for 34.2% of all transportation use in 1970, or 5.6×10^{15} Btu's. [I-11] Linear extrapolation of Hirst's data indicates an urban automobile usage of 36.7% of all transportation in 1975. Using the above estimate for total transportation use, this amounts to 9.2% of the total U.S. energy consumption for 1975 for urban automobile use.

Approximately 42% of all urban automobile transportation is for the purpose of commuting to work or other work-related trips. [I-12] This usage amounts to 3.9% of the total U.S. energy consumption, or 15.4% of U.S. transportation energy consumption. If these percentages of usage remain constant, commuting will account for 2.9×10^{15} Btu's in 1975. Thus, each percent reduction in urban commuting could result in a total increase in U.S. energy conservation of about 30 trillion Btu's annually. This figure can be converted to equivalent kilowatt hours by noting that there are 3413 Btu's per kilowatt hour. Consequently, a reduction in urban commuting of only 1% would result in an increase in total U.S. energy conservation of approximately 8.6 billion kilowatt hours annually. The average U.S. household is expected to consume 9730 kilowatt hours in 1975 [I-13]. Thus, a 1% reduction in commuting would save enough fuel energy to supply the residential electricity needs of a medium-sized city.

In addition to the energy required to commute, the commuting mode has also required the construction of major urban highway systems in most metropolitan areas. These systems are both inefficient (in terms of their unequal loading) and costly to build and maintain. The other transit option - widespread bus

networks and/or fixed rail transit - are equally costly and suffer from the same problems of unequal loading. A dilemma clearly exists. Although most major American cities have become dependent upon efficient and/or popular forms of transportation, escalating costs, energy shortages, traffic congestion and pollution may preclude total adherence to traditional transportation modes. Other alternatives must be considered.

C. AN OPTION - TELECOMMUTING

In considering ways to alleviate commuter traffic, one factor is critical: the type of work the commuter performs. Some work requires the physical presence of the worker at or near an immovable object or central location, e.g., the creation of physical goods in factories, the transfer of physical goods or the performance of a service requiring face-to-face meeting. Such work is heavily transportation dependent and it is difficult to foresee alternatives to transportation for workers engaged in these industries. However, along with the advent and growth of electronic and computer technologies, an increasing proportion of the population has been engaged in the creation, transfer, processing and/or storage of information - work that does not necessarily require the physical presence of the worker. Nonetheless, these "information industry" workers are still required to commute to and from central locations in major business districts. Given the capability of modern telecommunications and computer technology to efficiently produce, transmit and store information, it appears probable that

many information industry workers could "telecommute," i.e., perform their work using communications and computer technologies, at locations much closer to their homes than is the case now. If telecommuting could be shown to be feasible, an alternative to commuting would be available to a significant portion of the central business district labor force. It was this possibility that the USC research group considered, with the aim of defining the critical elements of the substitution and identifying the key policy areas associated with the substitution of telecommunications for transportation.

D. PREMISES

The central question of our research was: Can telecommunications and computer technologies be substituted for some portion of urban commuter traffic? Can such a substitution reduce commuter congestion and mitigate the major economic impacts of new commuter-oriented transportation systems? What are the possible societal impacts of the substitution? What policy questions should be considered at the federal, state, regional and local levels? The research emphasis was placed on the evaluation of three primary aspects of the telecommunications-transportation substitution:

1) Economic Incentives

A key premise in the research was that the prospects for substitution of telecommuting for commuting would be greatest where individual business firms or government agencies could perceive clear economic advantages to dispersing their labor forces from central business districts. Existence of this

economic advantage is a necessary, if not sufficient, condition for the decision by an individual firm to engage in telecommuting.

To evaluate the potential economic incentive, the team performed a preliminary case study of a typical information industry firm and evaluated the costs and benefits of telecommunications as an alternative to transportation for this firm.

2) Technological Base

It was apparent that a sufficiently advanced technological base was required to meet the work-related communications requirements of the firm. The team defined, therefore, the communication requirements of the information industry firm, developed a series of scenarios, assessed available technology in the context of the firm's requirements, designed a hypothetical communications network for the company, and performed a preliminary cost/benefit analysis.

3) Effectiveness

Since substitution is dependent on the ability of workers to perform their work in a telecommunications environment and their willingness to do so, the team attempted preliminary assessments of the effectiveness of the telecommuting mode. A series of surveys were developed and given to USC and Stanford University students who had opted for telecommunications over transportation by using the Interactive Instructional Television Systems at their schools. The students' attitudes and motivations were

studied. This portion of the research also required extensive background research into previous experiments on the effectiveness of telecommunications in various work environments.

E. SIGNIFICANCE

On the basis of the research, the team developed estimates of some of the major economic and social impacts of the telecommunications option. The primary impacts were projected as the development or extension of telecommunications networks, a reduction in energy use and changes in the form of delivered energy, and changes in transportation planning, design and growth. Areas of secondary impact are urban growth and land use patterns, new modes of business, options in resource conservation, and related societal problems.

The research team was concerned with questions of net societal benefit. If the net societal benefits are seen to be negative in either the long or short term, then it is imperative that adequate government policies - on all levels - be developed to eliminate, forestall, or mitigate any undesirable effects., particularly where there is otherwise an economic incentive to individual firms to use telecommunications. It is particularly important for government agencies to be aware of the public policy issues related to the telecommunications option, particularly if, as postulated, individual organizations choose this option on the basis of their own self interest - enlightened or otherwise.

The following sections of this report treat the methods and

results of the USC research and conclude with a discussion of some of the implications of the findings, particularly as they relate to public policy.

CHAPTER I. FOOTNOTES AND REFERENCES

1. Harkness, R.C., "Communications Substitutes for Travel: A Preliminary Assessment of their Potential for Reducing Urban Transportation Costs by Altering Office Location Patterns" (Ann Arbor, Michigan: University Microfilms, 1973), p.267.
2. U.S. Department of Transportation, "Suburbanization and its Implications for Urban Transportation Systems" (Washington, D.C.: U.S. Department of Transportation, Office of the Assistant Secretary for Systems Development and Technology, Office of R & D Policy, 1974), p.1.
3. U.S. Bureau of the Census, Statistical Abstract of the United States (Washington, D.C.: U.S. Government Printing Office, 1972).
4. Ibid., p.16
5. Gruen, Victor, "Centers for the Urban Environment: Survival of the Cities" (New York: Van Nostrand Reinhold Company, 1973), p. 163.
6. Hirst, Eric, "Energy Intensiveness of Passenger and Freight Transport Modes: 1950-1970" (Oak Ridge, Tennessee: Oak Ridge National Laboratory, ORNL-NSF Environmental Program, 1973), p. 23.
7. American Society for Engineering Education, "Interdisciplinary Research Topics in Urban Engineering: A report by the Urban Engineering Study Committee of the American Society for Engineering Education (Washington, D.C.: American Society for Engineering Education, October, 1969), pp. 198-199.
8. Ibid, p.200.
9. Ford Foundation Energy Policy Project, "Exploring Energy Choices," (Washington, D.C.: Ford Foundation Energy Policy Project, 1974), p.68.
This reference is drawn from a report issued by Stanford Research Institute, "Patterns of Energy Consumption in the United States," prepared for the Office of Science and Technology, Office of the President, Washington, D.C., 1972.
10. Hirst, op.cit., p. 24.
11. Ibid, p.24.
12. Automobile Manufacturers Association, Inc., "1971 Automobile Facts and Figures" (Detroit, Michigan: Automobile Manufacturers Association, Inc., 1971), p. 52.

13. Electrical World, September 15, 1969, p. 90.

CHAPTER II. LITERATURE SURVEY

From the outset of the project, the research team collected and evaluated information on related projects. This literature search revealed that a great deal of research has been and is being performed on the efficacy of telecommunications and computer technologies as a substitute for certain types of face-to-face transactions. A variety of uses of these technologies has been postulated and tested, ranging from telemedicine in rural areas to intra-city teleconferencing for city officials, to international scientific exchange via a computer network. The technologies considered include videophone, telephone, slow scan television, cable and computer data communications. The literature includes studies on the attitudinal and behavioral aspects of telecommunications use, reviews of the available technology, reports on specific experimental projects, and policy studies and projections. Several of the more important studies (in terms of the USC research) are discussed below.

A. Richard C. Harkness

A major compilation of previous work performed was available in a dissertation published by Richard Harkness - while he was at the University of Washington . [II-1] This work also includes a preliminary systems analysis of the substitutability of

telecommunications for transportation within a city. Harkness examined a hypothetical city with a radial transportation network and computed the savings in miles traveled and in energy consumption for a number of alternative configurations. Specifically, he postulated a central business district supplemented by a set of satellite work centers. His calculations indicate that, for his idealized circular city, four satellites should be located symmetrically at approximately the radial distance from the city center. Additional satellites would yield increasingly marginal improvement. Harkness was primarily concerned with the use of communications to cope with the growing number of jobs, so these increments would be dispersed from the central business district, the latter remaining at its current population level. The study is primarily theoretical; his representative information is not based on any specific city. One of the primary objectives of the USC research was to examine whether the savings predicted by Harkness could be realized in a practical situation.

2. Peter C. Goldmark and the "New Rural Society"

Under sponsorship of the U.S. Department of Housing and Urban Development, Goldmark Communications, Inc. and a research group at the University of Connecticut are developing background information for a demonstration project in which numerous low density rural communities are postulated as an alternative to urban high density living. The inhabitants of these new communities would communicate with each other and perform their

work via various telecommunications modes. The project anticipates that a spectrum of "urban" services, facilities and events would be available to the inhabitants of the new rural communities via telecommunications. This research is different from the USC research in that Goldmark anticipates an ultimate "spreading" effect throughout rural areas and a radically different structure for American society; the USC research, on the other hand, is based on the premise that the existing urban structure is likely to persist, although in a modified form, at least in the near term. (It could be said that the USC and Goldmark emphases are on the near and far ends of an evolutionary process, respectively.) Working from this premise, the USC research team considered alternate modes of evolution for our cities, given the options offered by the new communications and computer technologies. The USC research is directed toward revitalization of urban areas, with central business districts evolving from special use areas into communities that blend offices, living quarters, and recreational and entertainment facilities.

3. Bell Canada

The Business Planning Group of Bell Canada has been investigating the potential of using telecommunications as a substitute for inter-urban travel in Canada. They conclude that a potentially large market exists in Canada for this use of telecommunications, if there is public acceptance of the new mode. Researchers from Bell Canada have recently completed

preliminary interviews of approximately 40,000 travelers between Canadian cities to determine public attitudes toward travel and telecommunications substitutes.

Bell Canada has also been conducting research in teleconferencing for several years; this work has been done primarily by the Business Planning Group in Montreal. Under the direction of Lawrence Day, the work has been concerned with five major areas of impact: 1) the availability of new technologies and possibilities for their application; 2) information transfer volume, i.e., definition of those transactions which are amenable to performance via a telecommunications system; 3) cost-benefit analyses; 4) behavioral and attitudinal factors; and 5) ecological, environmental and resource allocation concerns. Bell Canada has also shown considerable interest in computer augmented conferencing (CAC), which represents a merging of computer and communications systems. In the past, the Business Planning Group sponsored audio teleconferences between various institutions on the problems associated with a telecommunications-transportation tradeoff; they are now involved in sponsoring a series of computer augmented conferences.

4. Office of Emergency Preparedness

In 1972, the Office of Emergency Preparedness investigated the potential of teleconferencing as a substitute for transportation within a large government organization. Murray Turoff, former Assistant Director for Resource Analysis in the Office of Emergency Preparedness (and now Professor, Department

of Computer Sciences, Newark College of Engineering), has written several articles propounding the special capabilities of teleconferencing. He favors computer augmented conferencing and similar data network communication modes for two reasons: 1) an increased capability for group interaction and efficient communication with others, and 2) cost effectiveness. He feels that computer augmented conferencing is particularly suited to group communication because it is asynchronous. Verbal communication, he notes, "represents a synchronous form of communication. Individual participation is sequential and under the control of the group, along with any explicit or implicit rules of order that apply. . .one may either listen or talk when allowed to." [II-2] Computer conferencing, on the other hand, gives the individual control over entry (talking) and reviewing (listening).

Another advantage of computer assisted communication is the ease of reference, since each message is assigned an entry number. By using identifiers, the computer can also sort out related messages over an extended period of time and provide "clean" conversations on a particular subject. Another advantage is the ability to enter private messages, a subgroup capability which Turoff terms "whispering." Finally, computer augmented communication permits participation over time, i.e., groups do not need to be called together from various geographical locations, or even, as in a telephone or video conference, required to talk and/or listen at the same time. Asynchronous teleconferencing via computer permits entry and review at both a

convenient time and place.

Dr. Turoff participated in a computer augmented conferencing system called EMISARI (Emergency Management Information System and Reference Index) which operated at the Office of Emergency Preparedness. As indicated by the system name, the network was utilized primarily as a management information tool, transmitting information between parties. Although a real-time computerized conference capability existed, its use was confined to clarification of changes in reporting formats or instruction.

5. Institute for the Future

Sponsored by ARPA and the National Science Foundation, the Institute for the Future (IFF) in Menlo Park, California, has been developing a computer program called FORUM, which is designed to permit effective computer augmented conferencing. The FORUM system provides a unique mode of remote teleconferencing. It consists of a series of machine language programs that permit users to send messages to a central file. Messages are numbered sequentially and stored. They can be retrieved by message number or other index. More importantly, since at one point the system was embedded in the TENEX executive of the ARPA network, messages could be sent to all conference participants who were on-line at the time of transmission. FORUM provides both a real-time capability as well as a permanent, retrievable, hardcopy record.

In late January and early February, 1974, a FORUM conference was held under the sponsorship of Bell Canada. Participants "attended" from all over the United States, Canada, and England.

However, the representatives to the conference did not travel to convene at a central place for a set period of time; rather, they participated via terminals, which they used at their homes and offices, accessing the conference at random times. The following is a typical set of entries, demonstrating the capability of computer augmented conferencing to link participants across space and through time. It also illustrates the use of the technique to clarify ambiguities in terminology occurring between disciplines. The participants are, respectively, from London, England; Montreal, Canada; Menlo Park, California; and Washington, D.C. The time notes before each entry are the log-on times referenced to Eastern Standard Time.

- (88) WILLIAMS THU 31-JAN-74 3:20 AM. RE 86, I VOTE YES, BUT WOULD LIKE TO SUGGEST IN ADDITION THAT THE DEVELOPMENT OF METHODOLOGIES TO ANSWER THESE VARIOUS QUESTIONS MIGHT MERIT A TOPIC SECTION IN ITS OWN RIGHT. OFTEN OUR ANSWERS ARE ONLY AS GOOD AS OUR METHODS. RE 78, WE HAVE BRUCE CHRISTIE WITH US AS CSG, HE WAS THE NRS PSYCHOLOGIST UNTIL OCT 1973, AND IS STILL IN CLOSE TOUCH WITH THEIR WORK. I CAN CALL HIM IN AT ANY TIME. (FORUM
- (89) KOLLEN (CHRMN) THU 31-JAN-74 8:44 AM. IN REGARDS TO (86), I AGREE WITH THE STATEMENT IN GENERAL BUT WOULD LIKE TO SEE MORE ELABORATION OF POINT 3 WITHIN THIS STATEMENT. I FEEL THAT AT LEAST FOR ME, THIS POINT IS SOMEWHAT AMBIGUOUS. IN ADDITION, IF THERE ARE OTHER PARTICIPANTS WHICH HAVE TROUBLE WITH ANY OF THE STATED AREAS OF DISCUSSION, PLEASE EXPRESS YOUR RESERVATIONS AT THIS TIME!
- (90) JOHANSON THU 31-JAN-74 9:09 AM. I AGREE WITH 88 THAT METHODS ARE CRUCIAL TO THE DISCUSSION, AND WOULD SUGGEST THAT THIS BE INCLUDED UNDER TOPIC 3. I SEE THIS AS RELATING THE TECHNICAL AND SOCIAL DIMENSIONS OF THIS CONFERENCE. THIS CAN, OF COURSE, BE MADE MORE SPECIFIC AS WE GO ALONG AND HAVE CONSIDERED THE FIRST 2 POINTS IN THE AGENDA.
- (91) MORGAN THU 31-JAN-74 9:18 AM. I THINK WE MAY HAVE

PEOPLE TALKING ABOUT TWO THINGS HERE, WHEN I USED THE WORD METHODOLOGIES EARLIER IT WAS IN THE CONTEXT OF RESEARCH. I THINK THE SAME MEANING IS INTENDED BY WILLIAMS IN 88. I AM NOT SO SURE THAT THE SAME MEANING APPLIES IN (90). CLARIFICATION?

(92) JOHANSON THU 31-JAN-74 9:29 AM. RE 91 I ALSO MEANT METHODOLOGY WITHIN THE CONTEXT OF RESEARCH.

(93) KOLLEN (CHRMN) THU 31-JAN-74 9:29 AM. RE 91 THE FORMAL AGENDA OF THE TRAVEL/COMMUNICATION TRADEOFF CONFERENCE IS AS FOLLOWS: 1. NEEDS OF TRAVEL AND WHAT TYPES OF TELECOM CAPABILITIES WOULD SUPPLEMENT OR SUBSTITUTE FOR THESE NEEDS. 2. HOW WE COMMUNICATE (E.G., FORMAT, CONTEXT, ETC.) SEE STATEMENT (62) FOR AN ELABORATION OF THIS POINT. 3. HOW CAN COMMUNICATIONS AND NETWORK TECHNOLOGY ENTER INTO THE PROCESS OF COMMUNICATING GIVEN THE UNDERSTANDING OFFERED IN POINTS 1 and 2 ABOVE.

6. Human Sciences Research, Inc.

The Social Policy and Programs Branch of the Department of Communications (Canada) and the Human Sciences Research, Inc., recently completed a research project on the effectiveness of teleconferencing utilizing an audio system, an audio-graphic system, and two slightly different audio-video systems. The researchers reported that:

- 1) careful definition of the information and communications needs of the organization should be made before selection of a teleconferencing system;
- 2) telecommunications has the capability for permitting meetings that might not have been held in the absence of the telecommunications system;
- 3) telecommunications is more efficient than face-to-face meetings both in permitting better decision making and in facilitating exchanges between geographically separated participants;
- 4) telecommunications promotes the use of multiple inputs in a rapidly changing situation;
- 5) telecommunications systems improve communications and thereby contribute to organizational effectiveness; and
- 6) video, although far more expensive, did not greatly improve either user receptivity or system effectiveness over the use of audio augmented by an alphanumeric display using audio bandwidths.

These conclusions support the hypothesis that a relatively inexpensive telecommunications system can effectively transmit information and, accordingly, can improve organizational efficiency. Further, such systems may offer, in some situations, unique and desirable added capabilities. The point that the system must be matched to the needs of the organization is almost a truism, but as a fundamental factor in the system's success it should be reiterated.

7. Communications Studies Group, Joint Unit for Planning Research

Similar work has been performed in the United Kingdom by Alex Reid and the Communications Studies Group (CSG) of the Joint Unit for Planning Research at the University College, London. The CSG compared the effectiveness of communications by audio only and by videophone with face-to-face interactions in an attempt to ascertain the importance of the visual channel. Their pilot studies indicate that the presence of a visual channel neither facilitates nor hinders communication that is primarily transmission of information. However, when subjects are engaged in bargaining or problem solving, the visual channel is perceived as being more important.

The CSG found that subject perceptions of their interactions varied with medium type. This is important since perceptions play a role in the acceptability of a channel and acceptability is an important part of effectiveness. In several experiments, subjects displayed a lack of confidence in judgments made in

audio-communications as opposed to judgments made in face-to-face interactions. However, this loss of confidence was not warranted in all cases. The Communications Studies Group suggests that classes of communications tasks, including tasks requiring judgments may be accomplished with the same end results with or without a visual channel. The critical point is again a definition of tasks; in the design of the communications system, it must be determined if visual cues are germane to the task involved. However, in most cases, Reid concluded visual links were not necessary.

8. New York Metropolitan Regional Council (MRC)

Under a grant from the National Science Foundation, the New York Metropolitan Regional Council is investigating the effectiveness of video in providing expanded opportunities for interaction among nine local government complexes in the metropolitan New York area. A two-way experimental TV system was installed in 1973 to permit conferences among the various local government offices, which are located at points in the greater New York metropolitan area. Technically, the system consists of a central station in Manhattan and nine satellite stations which can communicate with each other via the central station.

Several important distinctions can be made between the Metropolitan Regional Council experiment and the ones discussed previously. First, the MRC system is not designed to replace functions previously performed by other means, but rather to increase productivity by offering a new spectrum of functions

.33

that would not be performed otherwise. Second, the system is not being tested for effectiveness against an existing system; rather, its effectiveness will be tested through user response. If the users indicate that the system effectively increased interaction among the nine government offices, then the system will be judged favorably.

9. Confravision

Another system meriting mention is the Confravision system which is operated by the United Kingdom Post Office. A similar system is in use in Canada under the Department of Communications. Confravision is a television system permitting city-to-city meetings between London, Bristol, Birmingham, Manchester and Glasgow. Television studios in each city are specifically arranged for business meetings and as many as five people can be seen on the screen simultaneously by the viewer. Stereo sound permits easy speaker identification. Charts, diagrams, models, etc. can be displayed by use of a separate camera. The system is self-operated by the participants to ensure privacy.

SUMMARY

1. INFORMATION IS AMENABLE TO TRANSFER BY TELECOMMUNICATIONS

Most experiments have indicated that a non-visual (audio) link is sufficient for the rapid and effective transfer of routine information. In some experimental cases, video was felt to be more effective when the interactions involved problem-solving, bargaining, or other confrontations where

nuances of expression are more critical. Studies reaching such conclusions, however, did not include effectiveness measurements on computer augmented conferencing systems like FORUM or EMISARI which, through their asynchronous nature, encourage greater interaction, more open and rapid response, and nuances of verbal, if not tonal or facial, expression. Such systems also provide the capability for hard copy retrieval and reference messages. At this time, no experiments have been performed to measure these capabilities in an actual conferencing situation where both routine and theoretical information was exchanged. Nor have computer augmented and audio conferencing systems been studied together, adding the possibility of including tonal nuances in the information transfer process.

2. TRANSFER OF INFORMATION VIA TELECOMMUNICATIONS IS FELT TO BE EFFECTIVE

All studies performed to date have supported the effectiveness of transfer of information by telecommunications. User support increases through time and through additional use. Again, the data is developed primarily for audio-only and video systems. No comparative experiments have been performed in this regard for computer augmented conferences where several types of information were being transmitted. No effectiveness studies have been performed for clerical level workers; such studies are long overdue, particularly in light of recent advances in terminal design and natural language programs.

3. SYSTEM NEEDS MUST BE DEFINED PRIOR TO SELECTION OF THE

APPROPRIATE CONFIGURATION

This statement may appear simplistic, but every study to date has stressed the importance of carefully defining information flows and communication requirements. Without such definition, the system may not be appropriate and therefore would be ineffective. The analysis of information industries and the case studies presented in the following chapters were predicated, to a large degree, upon the need to identify the basic formal and informal communication needs and task parameters of a major segment of the white collar labor force. Such definition, in turn, permitted estimation of the possible impact of telecommunications as a substitute for transportation.

CHAPTER II. FOOTNOTES & REFERENCES

1. Harkness, R.C., Communications Substitutes for Travel: A Preliminary Assessment of their Potential for Reducing Urban Transportation Costs by Altering Office Location Patterns. (Ann Arbor, Michigan: University Microfilms, 1973).

2. Turoff, Murray, "Human Communication via Data Networks," in "Computer Decisions," January, 1973, pp. 25-29.

III. THE INFORMATION INDUSTRY

A. GENERAL CHARACTERISTICS

For the purposes of this study, a component of the information industry was defined as any economic activity which is primarily involved in the storage, transfer, or manipulation of information. Typical information industry members are: insurance companies, accountant firms and others in the financial sector; educational institutions; the media; administrative operations of organizations regardless of their primary economic activity; and government agencies where the primary activity is information transfer. Less typical members of the information industry are those manufacturing firms which have largely automated their facilities through the use of numerically controlled machine tools and similar means of process control.

Many of the employees of information industry firms currently travel to and from locations in central business districts every day to interact with some form of communications or storage system such as a computer, the mail, or a physical filing system. Many of these jobs do not require frequent face-to-face interaction with other persons or the performance of physical services which require a common central location. Currently, more than half of the U.S. labor force comprises white collar and clerical workers, [III-1] the great majority of whom are in information industries or information segments of other industries. The white collar segment of the labor force is the

fastest growing segment in the United States. It has been forecast that white collar workers will increase from the level of 38.0 million in 1970 to 48.8 million in 1980, an annual growth rate of 2.5% [III-2]. For the same period, the annual growth rate for the U.S. population (205 million to 223 million) and the U.S. labor force (85.9 million to 102.5 million) is expected to be only .9% and 1.8% respectively. [III-3] Table III-1 gives a gross estimate of the information industry employment in 1970. [III-4]

Much of the research to date on telecommunications substitutes for travel has concentrated on the efficacy of telecommunications and computer technologies in the conduct of management operations within the information (and other) industries (cf. Chapter II). Many questions have been raised concerning the modes of telecommunications which are suitable for the conduct of management functions. The USC research, although recognizing that many questions raised in these areas are important, placed its emphasis on examination of the potential utility of "telecommuting" for the clerical and middle management workers in these industries, who together constitute the major portion of the labor force in the information industry. The economic and societal impacts of a conversion to telecommuting for this group could have far greater consequences than a similar conversion by management personnel. It should be noted, however, that the decision on the part of individual firms to make this substitution could conceivably be based on a disproportionately high emphasis on its perceived utility to management.

<u>TYPE</u>	<u>TOTAL IN CATEGORY (x 1000)</u>	<u>EST. CLERICAL AND RELATED NON - SUPERVISORY (x 1000)</u>	<u>SOURCE TABLE</u>
Federal Civilian (white collar)	2,113	634*	637
State & Local Government (white collar)		2,500	674
Banking, Finance & Insurance		2,900	364
Miscellaneous Business Services		644**	364
Transportation & Public Utilities (@ 8% of total employment)		366	364
Printing & Publishing (@ 15% of total employment)		166	364
Manufacturing, Durables (@ 6% of total)		672	
TOTAL CLERICAL AND EQUIVALENT INFORMATION INDUSTRIES EMPLOYMENT: INDUSTRIES EMPLOYMENT: <u>7,876,000</u>			

* GS-3 and below, @ 30% of total white collar workers

**40% of 1.6×10^6

TABLE III-1. INFORMATION INDUSTRY EMPLOYMENT
ESTIMATES, 1970

(Source: Statistical Abstracts, 1973)

B. EVOLUTIONARY PHASES

Before discussing the detailed characteristics of a member of the information industry, it is instructive to consider a potential evolutionary organizational process for information industry firms. Our somewhat arbitrary definitions of the steps in this process illustrate the major phases an organization may undergo in terms of its geographical structure and corresponding telecommunications and transportation interfaces.

Four evolutionary phases or forms of organizational structures were identified as they relate to the potential modes of application of telecommunications technology and their effect on public policy. These phases are: centralization, fragmentation, dispersion, and diffusion.

1. CENTRALIZATION

Centralization represents the current dominant mode. All administrative operations are located at a single site, with workers divided into functional groups according to the primary information product they produce. Where national organizations divide into regional offices, the regional home office replicates this monolithic structure. Both corporations "A" and "B" are centralized in Figure III-1A.

2. FRAGMENTATION

In this phase, coherent subunits of the central organization break off and relocate elsewhere. The communications boundaries of the organization are stretched and replaced by telecommunications or mail, but the communications within the

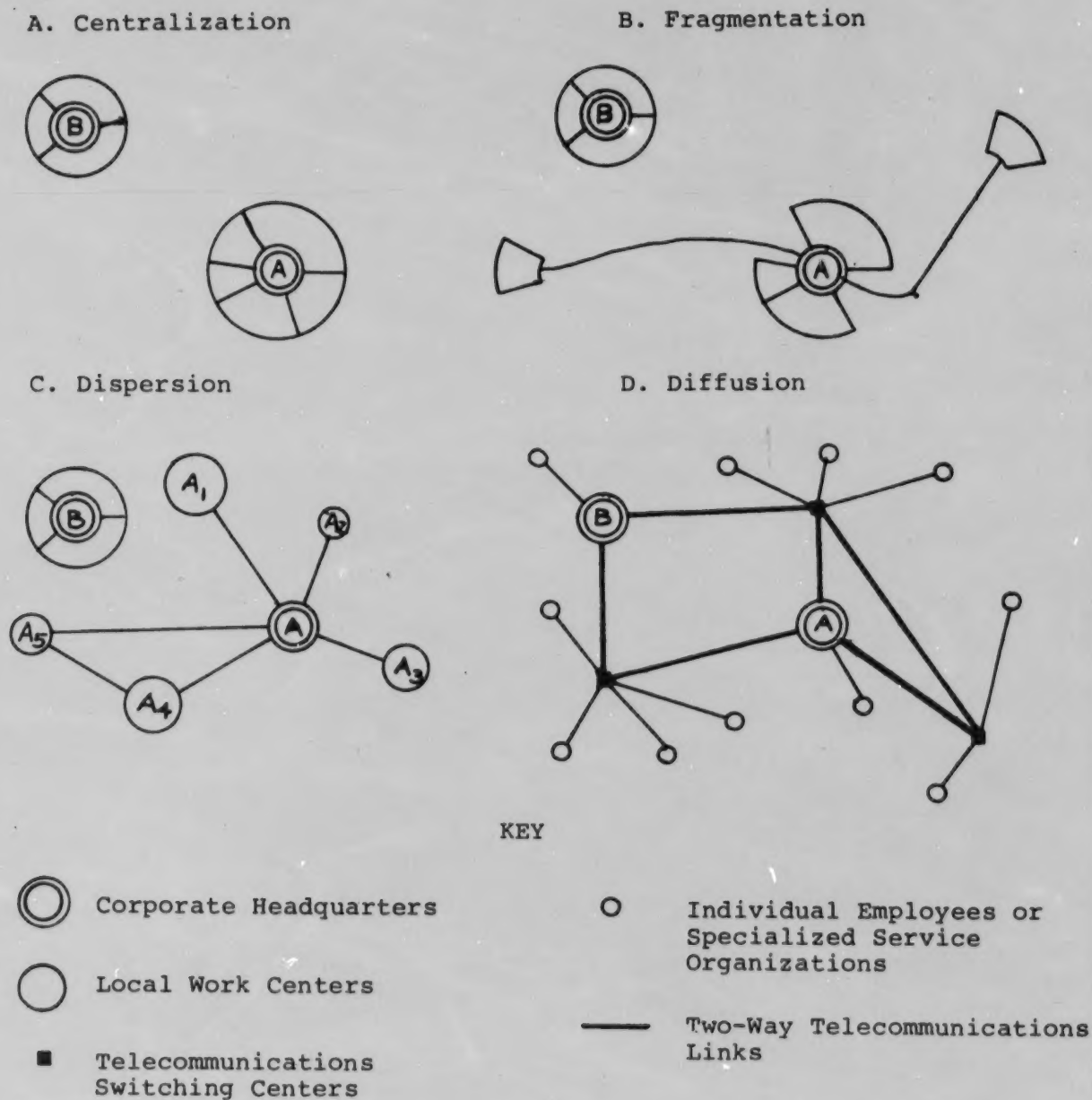


FIGURE III-1. Organizational Evolution: Two Cases, Corporations "A" and "B"

unit remain intact. Two common variations of fragmentation are BRANCHING, such as occurs in banks where the fragmented unit is a miniature replica of the parent, and SEGMENTING, where functional units such as data processing, accounting or marketing are separated from the central core (Corporation "A" in Figure III-1B).

Unfortunately, fragmentation appears to increase, rather than decrease commuting. This can be seen from the experience of many medium-sized cities such as Atlanta, Georgia, Washington, D.C., or Boston, Massachusetts, where a beltway has been built around the city. New commercial centers spring up along the beltway, particularly at the intersections with freeways that lead downtown. People who live on one part of the perimeter tend to work, by the perversity of human nature, on another part of the perimeter. Furthermore, many people who live inside the perimeter travel through downtown to reach their place of work. The net effect has been to increase the downtown congestion beyond that which would result from the growth of downtown office space itself, because of the large number of people who pass through downtown. In Los Angeles, for example, less than 20% of the people who travel into the downtown area actually stop there. [III-5]

3. DISPERSION

The third stage of decentralization is dispersion. In dispersion, the firm establishes a number of work locations throughout the city. Employees report to the location nearest

- 2 -

their homes, irrespective of the department in which they work (Corporation "A" in Figure III-1C; Corporation "B" is still centralized)). They obtain their information through the "central" computer. Supervision and coordination activities make use of communications and the computer rather than line-of-sight interaction as at present.

In dispersion, executives who require many face-to-face contacts to perform their jobs may still report to a central location to permit such interaction, but the great mass of clerical workers would be able to achieve substantial reductions in commuting. Dispersion would also permit firms to tap labor markets that are not presently available; for example, housewives working while their children are in school and high school students in the late afternoon.

4. DIFFUSION

The ultimate stage in this telecommunications-induced process is diffusion. In the diffusion stage, firms would maintain a relatively small core staff which may be dispersed. Peaks in work load would be handled by individual workers who offer their services through a telecommunications network to several different firms or clients (both corporations in Figure III-1D). This particular phenomenon is beginning to appear in the form of companies that offer temporary secretarial services and, of course, is common in the professions such as law.

A significant difference between diffusion and the previous stages is that diffusion requires the widespread availability of

switched data networks rather than private networks or leased line systems. Because of a variety of reasons, it is unlikely that the diffusion stage of decentralization will be acceptable to many large organizations in the near future. However, the possibilities of this mode of working may become increasingly attractive to smaller, service providing organizations which constitute a growing portion of society.

CHAPTER III. FOOTNOTES AND REFERENCES

1. U.S. Department of Labor, "Handbook of Labor Statistics (Washington, D.C.: U.S. Department of Labor, Bureau of Labor Statistics, 1973), p.39.
2. "Predicasts," Issue 53, October 26, 1973, p. A-5. "Predicasts" is a news service published by Predicasts, Inc., 200 University Circle Research Center, 11001 Cedar Avenue, Cleveland, Ohio 44106.
3. Ibid, p. A-5.
4. U.S. Bureau of the Census , "Statistical Abstract of the United States (Washington, D.C.: U.S. Bureau of the Census, 1973).
5. Statements by the Los Angeles City Traffic Engineer, 1974.

IV. CASE STUDIES

A. INTRODUCTION

Insurance and banking account for 3% of the gross national product of the United States (35.2 billion dollars in 1972; figures are unavailable for 1973). [IV-1] Most of the business offices for these two industries are located in large central headquarter buildings in urban central business districts. The main function of most of the employees in banking and insurance is the recording of transactions and the updating of computer files. The use of telecommunications and computer technology is already widespread in these industries. An expansion of the uses of telecommunications and computer technologies to permit decentralization of these industries from urban central business districts could have a significant impact on traffic congestion in urban areas.

Early in the project, a broad comparison was made of the banking and insurance industries. We found that the two industries differ considerably in their data processing operations, the most notable difference being that insurance companies are "stand alone" operations, in which the record keeping of one company is completely independent of any other insurance company, while banking is a highly interdependent industry.

The research team postulated that decentralization, using telecommunications, could occur spontaneously as it became economically attractive to individual companies or groups of

interrelated companies. The interdependent structure of the banking industry, depending as it does upon a complex network of financial reporting and document flow (especially checks), precluded a simple analysis of the process whereby the industry may further decentralize through adoption of telecommunications. The decision was consequently made to perform a detailed analysis of an insurance company as a quicker way to estimate the feasibility of the telecommunications-transportation tradeoff. A preliminary analysis was performed of the banking industry which indicated that similar tradeoffs would occur, provided that the core problems of achieving a secure means of electronic check transactions were to be resolved first.

B. INSURANCE COMPANY CASE

The research team contacted the western regional office of a major national insurance company to start development of data for the case study. The company has been extremely cooperative in providing information, the experience of key executives, and access to employees throughout the project. Their cooperation in supplying employee and task data is gratefully acknowledged. By mutual consent, the company is not named in this report. Examination of other companies in the industry leads the research team to believe that the factors presented here are typical of the industry.

Located in the central business district of Los Angeles, the company studied was faced with the problem that their present building was reaching saturation and was beginning to show signs

of age. Further, the neighborhood population had aged and the insurance company was no longer able to draw its labor force locally. The local management was aware that a decision regarding alteration of the organizational structure of the regional office was imminent, and the telecommunications-transportation option was one they wished to explore.

The central management on the east coast, although also interested in exploring the option, has a longstanding policy restricting the minimum size of any regional office to 1,000 employees. Given this restriction, the Los Angeles management could only consider a fragmented configuration. Nevertheless, the Los Angeles management cooperated in an investigation of a dispersed network of offices linked by a telecommunications network.

Most major insurance companies are concerned with two primary tasks: underwriting of new policies and record keeping on existing policies. Since the number of policy holders is usually large, most companies now keep their records on computer file, using large clerical staffs to update the information in the machine. Hence the primary work for a large portion of insurance company employees is information processing.

The insurance company studied conformed to this pattern. A large (IBM 370/155) computer services all the departments. Each department serves primarily to transform input information of a particular type into a form suitable for computer records. Even cursory analysis indicated that no technical need existed for the employees who transformed information for the computer to be

located in the same building as the machine. However, it was not equally clear what other organizational considerations existed that required keeping the various groups housed centrally. The USC research team, therefore, undertook a study of 1) the organization of the insurance company, 2) the tasks performed by the employees and their communication requirements, and 3) the characteristics of satellite offices of the company.

C. INSURANCE COMPANY ORGANIZATION

The labor force in the headquarters consists of three distinct groups of employees: executives, middle management and clerical. A breakdown of these employees by job level, salary and executive titles is given in Table IV-1. Executives include high line and staff positions and represent 6% of the staff. Middle management represents 27% of the total, including both supervisors of clerical workers and functional specialists. The remaining 67% are clerical workers with job titles such as clerk, typist, keypunch operator, and service clerk. The element of greatest importance is the large fraction of the labor force that is clerical. Since these employees constitute the majority of the workers and do (as will be shown later) the majority of the traveling to work, we concentrated on investigating the implications of substituting communications for transportation for these workers. Most of these workers commute to the headquarters building located near the Los Angeles central business district (CBD). A few of the employees commute much shorter distances to two small satellite locations.

<u>CLASS</u>	<u>LEVEL</u>	<u>NUMBER</u>	<u>SUB-TOTAL</u>	<u>SALARY/WEEK (MEDIAN)</u>	<u>TITLE</u>
Clerical	1	3		103	
	2	197		108	
	3	424		115	
	4	402		123	
	5	384		135	
	6	278	1,688	144	
	7	183		157	
	8	177		169	
	9	143		183	
	10	60		199	
	11	90		213	
	12	27	681	230	
					Associate Manager
	20	83			Manager
	60	44			Assoc. General Mgr.
	77	8			General Manager
	78	3			Dir. of Agencies
	79	4			Vice-President
	80	4			Vice-President
	82	1			Sr. Vice-President
	84	1			
			<u>148</u>		
			2,517		

TABLE IV-1. Insurance Company Employees

Definition of the internal organizational structure was accomplished through a series of interviews with key personnel from the divisions within the company. These interviews, which ranged from the vice-presidential level to the first supervisory level, showed that the company consists of ten major groups. These groups are concerned with one or more types of insurance, investment and/or support services (Figure IV-1).

The insurance company fills its clerical positions primarily by hiring recent high school graduates. Thus, the company serves as an entry level employer. The company believes this practice provides employees of sufficient skill at minimum cost. The clerical workers constitute a non-union labor force, which the company prefers. These advantages are offset by a very rapid turnover rate for clerical personnel (100% every three years) with a concomitant need for a large potential labor pool and consequent high training costs.

At middle management and executive levels, the company provides almost complete job security; the employees at these levels tend to stay with the company for their entire working career.

The company provides several fringe benefits at its central building that are not provided at the satellite locations. These benefits include free parking, a slightly higher salary (relative to equivalent work in other areas of the city), free hot lunches, reduced insurance rates, job security and a free annual physical examination. Identification of these benefits is important since the creation of decentralized regional offices would permit the

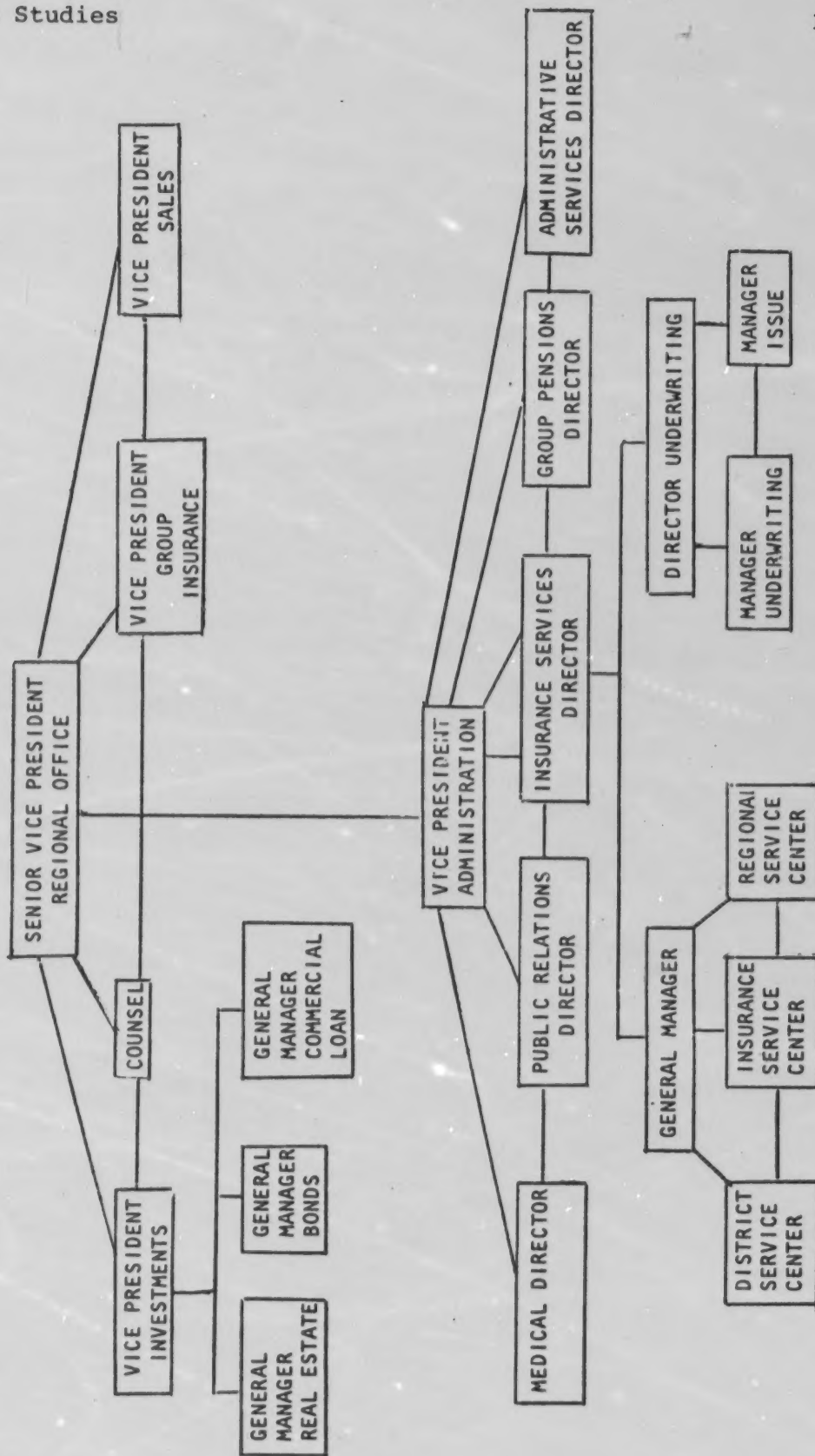


FIGURE IV-1. Insurance Company Organization

company to modify some of these benefits.

D. INSURANCE COMPANY COMMUNICATIONS REQUIREMENTS

The insurance company maintains a central computer file on its approximately 1,000,000 policies. Data are recorded on tape and on disc. A policy is accessed about once a month, on the average. Because of a limited time sharing capability, the IBM 370/155 and 360/65 computers are operated principally in batch mode. The computers are operated 24 hours a day, seven days a week and are staffed by 160 employees. In addition to updating the files on active policies, the computer is used for accounting, payroll and other administrative functions. A detailed breakdown of the functions performed is shown in Table IV-2. The computers are augmented by a variety of peripheral supporting equipment such as line printers, disc drives and tape files.

The communications requirements and tasks of two representative divisions - the Insurance Service Center and the Underwriting Division - were studied in detail. The functions performed by these divisions were flow charted to define the relationships between the various sectors in the divisions and between the divisions and other groups. This portion of the report is devoted to a summary of the work task analysis, internal communications requirements, volume of transactions, and the relationship between the divisions studied and the central computer.

1. Insurance Service Center

SECTION	FUNCTION	STAFF	
		Level	Title
Administrative	- Provides coordination on new and revised EAM systems, operator training programs and machine usage reports. - Conducts research on machines and equipment, and quality control analysis of complaint areas. - Maintains accounting records on equipment and controls payment of rental and other charges. - Maintains divisional attendance records.	6	Procedure Clerk
Perforating	Keypunches and verifies accounting cards for claims, payroll, dividends, debit insurance, issue, IRS interest reporting, mortgage loan, policy loan and agents accounts.	5 4 3	Advanced Keypunch Senior Keypunch Keypunch Operator
Perforating (2nd shift)	Performs perforating and punch card accounting procedures	25 1 4 1 1 4 7 5 22	Advance Operator Senior Operator Advanced KPO EAM Operator Senior KPO Keypunch Operator
(3rd Shift)	Performs punch card accounting procedures shown in operating manual.	6 5 4	Advanced EAM Op. Senior EAM Operator EAM Operator
(1st Shift)	Performs punch card accounting procedures involving claims, controllers error analysis, cost analysis, disbursements, general ledger, issue, mortgage loans, payroll, personnel records & retirement.	7 6 5 4	Computer Operator Advance EAM Operator Senior EAM Operator EAM Operator

TABLE IV-2. Functions of Electronic Operating Division
(continued next two pages)

SECTION	FUNCTION	STAFF		
		Level	Title	Number
Computer Operation	1. Operates S/370 and S/360 2. Records machine usage, error and production statistics	12	Advanced Head Op.	3
		11	Head Operator	6
Production Control	1. Allots time and equipment to jobs for processing. 2. Maintains all weekly production schedules. 3. Controls Allocation and use of magnetic tape 4. Maintains and controls tape control file and records protection. 5. Controls the quality and flow of all input and output for computer runs. 6. Prepared equipment utilization and cost allocation reports	9	Console Operator	9
			Computer Operator	11
			EDP Operator	9
			Tape Librarian	2
			Operator Trainee	2
			Computer Service Clk	4
Service	1. Maintains and controls all stock, including cards, forms, stationery & supplies 2. Maintains retention files 3. Provides bursting of all continuous forms, binding service for the division, and delivery of reports.	8	Production Coord.	46
		4	Transaction Control	3
Technical Services	1. Provides technical support for Op. Systems and software users. 2. Develops and/or modifies programs for internal utility application. 3. Coordinates the definition and resolution of operational problems. 4. Reviews and establishes JCL content for new or altered programs.			2
				5
				7
				5
Service	1. Maintains and controls all stock, including cards, forms, stationery & supplies 2. Maintains retention files 3. Provides bursting of all continuous forms, binding service for the division, and delivery of reports.	4	Computer Service Clerk	1
		3	Service Clerk	6
Technical Services	1. Provides technical support for Op. Systems and software users. 2. Develops and/or modifies programs for internal utility application. 3. Coordinates the definition and resolution of operational problems. 4. Reviews and establishes JCL content for new or altered programs.			7
				7
				8
				8

TABLE IV-2. Functions of Electronic Operating Division (continued)

SECTION	FUNCTION	STAFF		
		Level	Title	Number
Systems Coordination	1. Reviews and assists the installation of systems to be installed on a production basis. 2. Maintains controls and recommends improvements to systems already in production. 3. Reviews, sets up and controls special one time jobs. 4. Plans future schedules, coordinates holiday and year-end schedules	11	Assistant Analyst	1
		9	Systems Examiner	1
		7	Machine Technician	1
		4	Transaction Clerk	2
				<u>5</u>

TABLE IV-2. Functions of Electronic Operating Division

The Insurance Service Center (ISC) is responsible for maintaining the records on 442,229 individual life and health policies. Two other major divisions, the Regional Service Center and the District Service Center, perform essentially the same tasks. The Center consists of 178 employees, of whom six are executives, 25 are middle level managers, and 147 are clerical. This division makes 15.7 changes per 1,000 policies in force per week. Its input to the computer is of three types:

- | | |
|---------------------------------|---------------------|
| 1. Optical scanner processing - | 24,370 entries/week |
| 2. Punched card input - | 3,568 entries/week |
| 3. Magnetic tape - | 136 entries/week |

A summary of the functions performed by the Insurance Service Center is presented in Table IV-3. Figure IV-2 details the flow of work for one function, the processing of premium remittances.

The ISC Division needs to contact several other sectors of the company with some frequency. In particular, the ISC Division contacts the following units:

1. Finance Division

The personal checks, money orders, and cash that are received as payment for insurance premiums are taken to the Finance Division or Accounting; the Finance Division deposits these assets at a local bank. This occurs several times a day.

2. Computer Division

The completed data processing input forms are gathered at the end of each working day and sent to the Computer Division for processing.

3. Answer Inquiries

The ISC Division answers inquiries from insurance agents, policy holders and administrative insurance personnel concerning the status of a policy. The frequency varies, but generally 20-25 phone inquiries per day are processed. The

SECTION	FUNCTION	STAFF	
		Level	Title
Change & Reinstatement	1. Changes involving kind, amounts, date, age, ratings & irregular premiums for Ordinary and Health policies	7	Change approver
	2. Duplicate policy transactions.	6	Change Examiner
	3. Ordinary and health reinstatements	5	Medical Approver
	4. Conversion of term riders & policies	5	Asst. Examiner
	5. Insertion and removal of Ordinary and Health policies under special reinsurance plans	4	Change Coder
	6. Batches input and matches computer output with source documents.	3	Reinstatement Clerk
	7. Reviews and attests policies and endorsements.	3	Service Clerk
Rights & Values	1. Perform special policy calculations	2	Change clerk
	2. Calculation of charges, allowances and commissions on Ordinary and Health Insurance policy changes.		
	3. Special Settlement Option Clauses for New Issue and in force Ordinary policies.	38	
	4. Transfer of ownership, extension of rights, and limitation of rights.	8	Calculated Approver
	5. Records and discharge of assignments.	7	Calculated Reviewer
	6. Name and beneficiary changes on ordinary policies.	5	Clause Clerk
	7. Batches input and matches computer output with source documents	4	Assignment Clerk
Commission	1. Updates commission data on computer records	3	Clause Coder
	2. Processes commission adjustments	2	Service Clerk
	3. Processes credit and valuation adjustments	4	
	4. Replies to correspondence regarding payments.	18	
	5. Controls assignments of servicing agents	6	Computer Clerk
	6. Codes the commission and valuation transactions.	5	Control Clerk
	7. Controls work in to and out of the section.	3	Commission Clerk

TABLE IV-3. Functions Performed by ISC (continued next page)

SECTION	FUNCTION	STAFF		Level	Title	Number
Service	1. Receives, sorts & delivers incoming mail	5			Service clerk	2
	2. Provides messenger service.	4			Change typists	5
	3. Delivers keypunch briefs to keypunch area	3			Clerk typists	1
	4. Handles and orders all supplies.	2			Telephone clerk	2
	5. Types policies, riders and alteration sheets.					<u>10</u>
Disbursement	6. Types all settlement option cases					
	7. Types checks prepared outside of the computer					
	8. Types register cards on inter-office transfers.					
	9. Types miscellaneous letters & memos.					
	1. Approves all dividend and loan transactions	6			Disbursement App.	4
Billing and Remittance	2. Adjusts computer master records for errors.	5			Corr. Clerk	7
	3. Prepares accounting vouchers for adjustment.	4			Internal Trans.	1
	4. Controls and processes special handling items.	4			Sr. Clerk	3
	5. Replies to correspondence regarding policies.	3			Service Clerk	2
						<u>22</u>
Billing and Remittance	1. Processes premium and policy loan remittance.	6			Accept. Clerk	17
	2. Controls new business remittances.	5			New Bus. Clerk	6
	3. Controls release of checks for over-remittance.	3			Control Clerk	9
	4. Handles voucher functions & related deposits.					<u>32</u>

TABLE IV-3. Functions Performed by ISC (continued next page)

SECTION	FUNCTION	STAFF		
		Level	Title	Number
Reconciliation	1. Handles requests for duplicate premium notice. 2. Investigates error conditions with remittance. 3. Investigates overdue remittances received. 4. Handles requests to pay premium in advance. 5. Handles requests for return of premium paid. 6. Handles requests for investigations. 7. Processes protested checks.	5	Service Clerk	4
		5	Reconciliation Clerk	13
		3	Corr. Clerk	7
				<u>24</u>

TABLE IV-3. Functions Performed by ISC

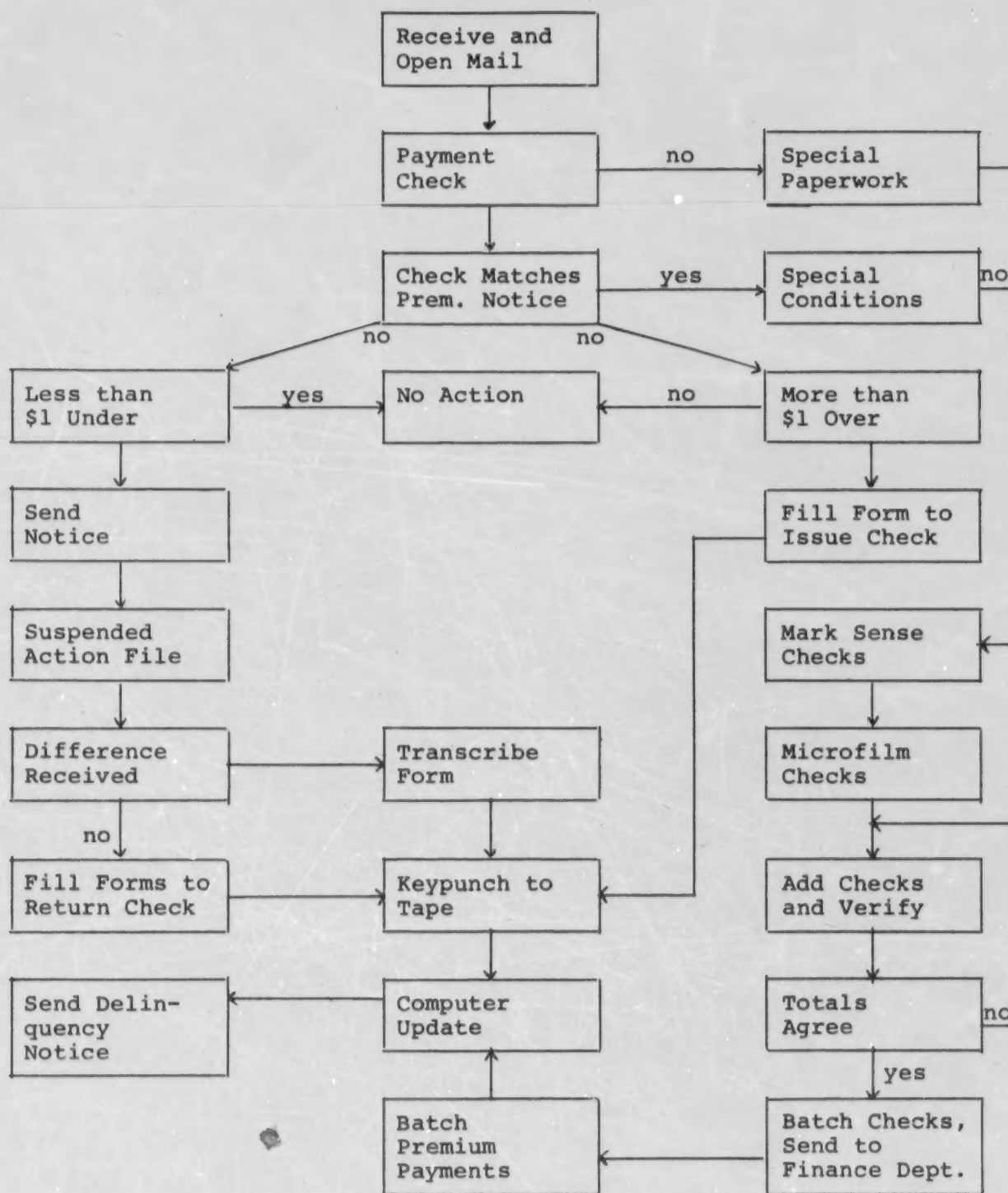


FIGURE IV-2. Processing of Premium Remittance

contact requirements of the Insurance Service Center are shown in Figure IV-3.

Analysis of the flow of information within the ISC Division leads to the following conclusions:

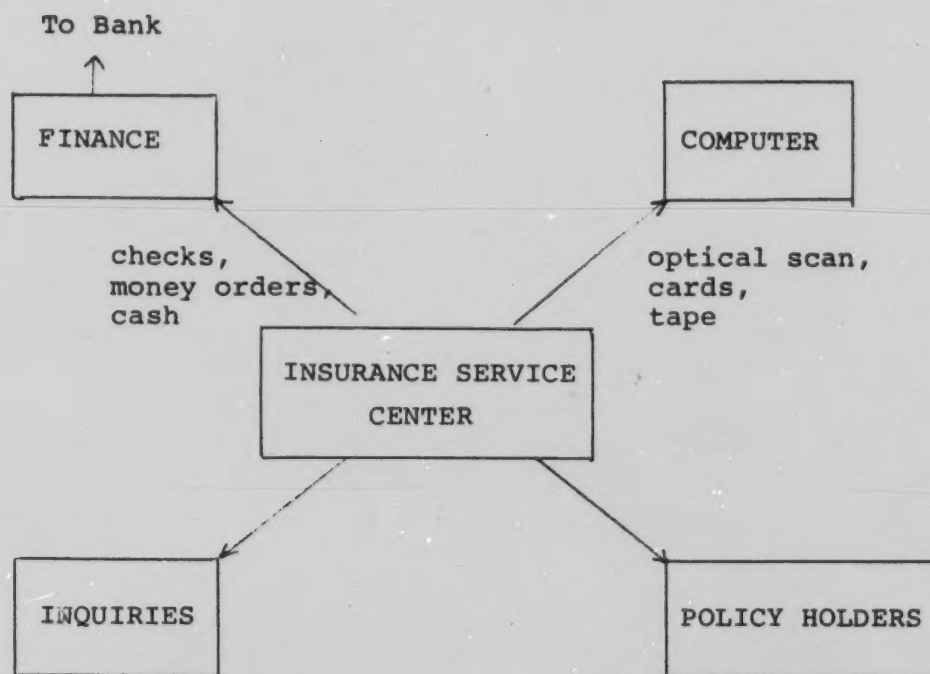
1. ISC is a highly self-contained division. The input into the division consists largely of mail sent to pay premiums or change information on an insurance policy. The output from the division is sent to two other divisions for further processing.
2. Speed is not a critical factor in the ISC operations. The data processing division operates on a batch mode input basis, and most large computer programs are run during off-peak hours. In addition, the need for newly updated insurance policies is not critical. A 4 to 5 day total processing time is considered adequate.
3. System security does not present a problem since the information contained in an insurance policy is usually not considered to be sensitive.
4. Since the computer system operates in a batch processing mode, the computer operating system does not have to be continually available for on-line interrogation.
5. Any input errors to the computer can be removed during a subsequent computer processing cycle.

2. Underwriting Division

The primary function of the Underwriting Division is to accept or reject new applications for life and health insurance. Table IV-4 details the functions performed by the various sections of the Underwriting Division. The division consists of 6 executives, 47 middle level managers, and 47 clerical workers. Between 50,000 and 60,000 policies are issued per month. A detailed flow chart of this process is shown in Figure IV-4.

Applications received in the life section of the Underwriting Division are placed in one of three categories:

1. A Cases - No further information required for a decision.

Contact Requirements

ISC - Finance: 3-5/day
ISC - Computer: 1/day
ISC - Inquiries: 20-25/day
ISC - Mail: 1/day

FIGURE IV-3. Contact Requirements of the Insurance Service Center

SECTION	FUNCTION	STAFF		
		Level	Title	Number
Mail	1. Alphabetize applications ready for pending file. 2. Assembles and traces new files and correspondence pertinent to processing new business. 3. Processes status inquiries for the field. 4. Maintains ordinary life and health insurance rejection files. 5. Processes and maintains records and files for insurance committee cases. 6. Conducts related correspondence. 7. Categorizes new life business for distribution to underwriters. 8. Mails inspection order tickets. 9. Answers telephone status requests and maintains approval records.	4	Status Clerk	2
		4	Sr. Service Clk.	4
		3	Special Service Clerk	4
		2	Service Clerk	5
				<u>15</u>
Pending File	1. Maintains files of life and health insurance pending applications. 2. Credits doctors with medical fees. 3. Prepared individual order voucher for advance medical fee payments and daily summary voucher. 4. Controls combination cases at final action. 5. Searches for applications related to correspondence	4	Sr. File Clerk	6
		3	File Clerk	9
		2	Senior Clerk	3
				<u>18</u>
Typing	1. Provides special photo service. 2. Provides typing service for new business underwriting. 3. Types checks and controls advance medical fee payments.	4	Sr. Service Clk.	
		3	Senior Typist	
		2	Typist	

TABLE IV-4. Functions Performed by Underwriting Division (continued next page)

SECTION	FUNCTION	STAFF		
		Level	Title	Number
Change & Reinstatement	1. Processes subsequent additions and removals of insureds & dependents. 2. Conducts related correspondence. 3. Completes special projects necessitated by premium rating. 4. Maintains files containing pending applications 5. Matches correspondence and reports with appropriate files.	6	Underwriting Clerk	2
		5	Contract Clerk	1
				<u>3</u>
		9	Supervisor	1
		8	Change approver	1
Health Change and Reinstatement	1. Processes requests for reinstatement and changes on ordinary health ins. 2. Processes requests for changes on debit health insurance. 3. Conducts related correspondence with the field and policyholders. 4. Processes files pertinent to processing debit changes.	6	Change Clerk	1
		4	Policy Clerk	1
				<u>4</u>
		12	Underwriter	2
		10	Asst. Underwriter	1
Health Underwriting	1. Underwrites ordinary health insurance new business. 2. Provides reference service for changes reinstatements & unplaced changes. 3. Processes lists and reformation cases, group conversions. 4. Conducts correspondence. 5. Prepares cases for review & decision.	8	Underwriter Approver	6
				<u>9</u>
		12	Underwriter	9
		10	Asst. Underwriter	11
		8	Underwriter Approver	13
Life Underwriting	1. Underwrites new business applications. 2. Conducts related correspondence. 3. Provides underwriting decisions on changes & reinstatements. 4. Processes lift cases. 5. Directs inspection service. 6. Makes special underwriting studies and analyses.	6	Underwriter Clk.	7
				<u>40</u>

TABLE IV-4. Functions Performed by Underwriting Division

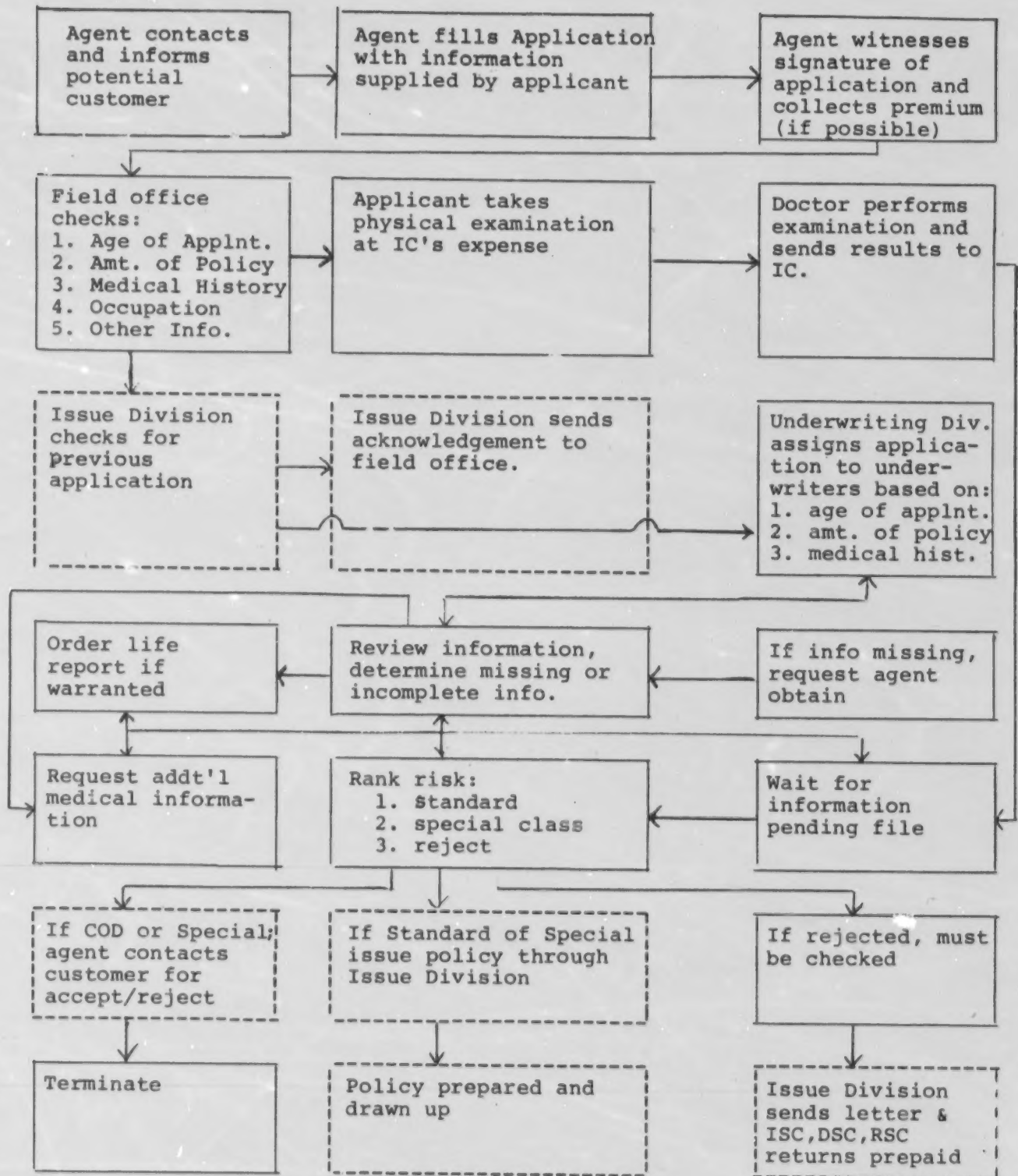


FIGURE IV-4. Life Underwriting Process

2. B Cases - Only an inspection required.

3. C Cases - All other cases

Sixty-five percent of the total number of cases are A cases and require no additional information to complete the application. B cases represent 20% of the total cases received. The remaining 15%, C cases, are more complex and require a more complete investigation.

Once an application has been evaluated and approved, the application officially becomes an insurance policy. This policy is then "issued" by entering the information into the computer system. The average policy issued has 125 characters of data.

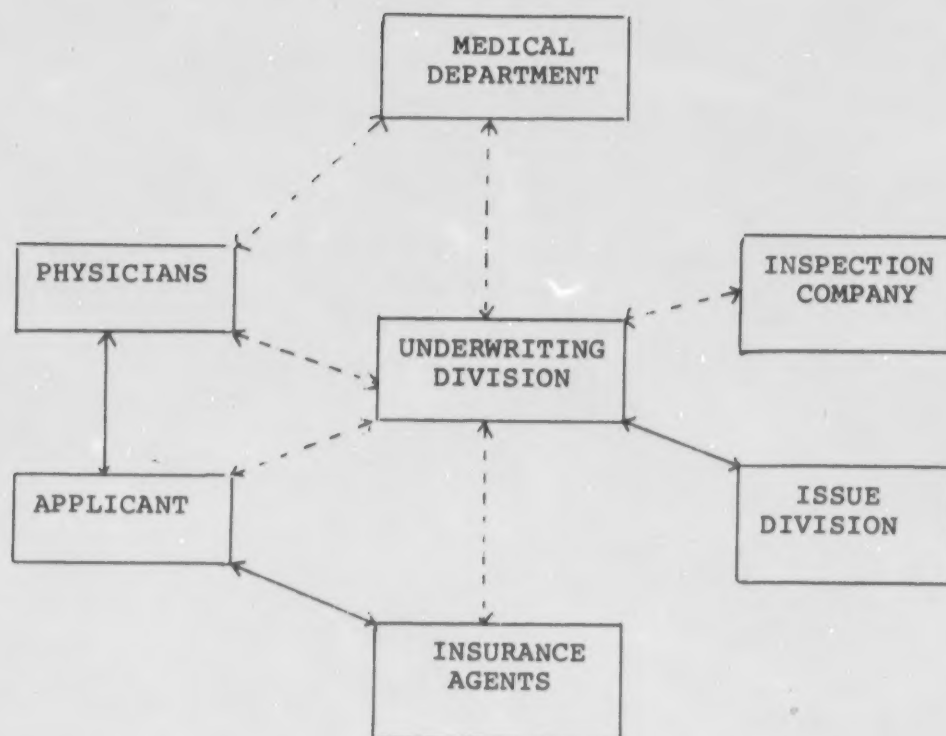
The Underwriting Division has the following contact needs (Figure IV-5):

1. Medical Department

Approximately 5% of the cases require the assistance of the Medical Department in making some of the technical judgments concerning the application. Test results must be reviewed, interpreted, and judgment made on the acceptability of the results. All of these contacts must be documented with written statements, since the judgments must be put in the case file. The contacts are usually through inter-departmental mail.

2. Insurance Agents

Agents who have sold an application will make a phone call or write a letter to the Underwriting Department concerning the status of a particular application. On pre-paid policies, the Underwriting Department must respond within 30 days with a final decision. On other policies the Underwriting Department must



----- Personal contact not required for adequate information transfer. That is, business operations allow communication via telephone, mail, 2-way computer tie-up and some teleconferencing.

_____ Personal contact required for adequate information transfer. That is, business operations frequently require face-to-face communication, manual transferring of documents and staff meetings where teleconferencing is impactical.

FIGURE IV-5. Contacts of Underwriting Division

respond within 45 days. Underwriting usually receives an average of seven phone calls and three letters per day from agents.

3. Physicians

For insurance policies that require a physician's examination, contacts are always written and sent through the mail.

4. Issue Division

The Issue Division is responsible for keypunching the insurance policy into the computer system once the Underwriting Division has decided to approve an insurance policy. There are extensive information contacts between these two divisions in the transition period in which an application becomes a policy. In addition, there are large amounts of physical paperwork passing between these two divisions.

The following conclusions can be reached about the operations of the Underwriting Division:

1. The Underwriting Division is an excellent example of an easily decentralizable sub-business within the insurance company.
2. The Underwriting Division has many contacts with other organizations, but except for the Issue Division, these are by phone or mail. Although contact with the Issue Division is currently face-to-face in many cases, the primary purpose of contact is the transfer of information. The physical location of the Underwriting Division is not an important factor in terms of performing the Underwriting function.

The research team, after study of the operations of both the Issue and Underwriting Divisions, concluded that:

No technical need existed for the employees of the Issue and Underwriting Divisions to be collocated in a central site. Although these divisions have many contacts with other components of the insurance company, these contacts are primarily made by phone or through the mail. Nor does extensive internal communication in either division preclude effective dispersal through the use of telecommunications.

A second critical point was that almost all of the routine operations of the divisions studied could be performed using off-the-shelf computer, terminal, and telecommunications technologies with the communications system operating at audio bandwidths.

These two conclusions were critical to both the feasibility and the design of the postulated network. The importance of the second conclusion will be elaborated upon in Chapter VII.

3) Satellite Offices

The insurance company presently operates two satellite offices, with 60 and 48 employees located 20 and 25 miles, respectively, from the central building. These satellites handle special tasks - such as data processing - and may be classified as being part of a fragmentation (segmentation) process, as defined in Chapter III. These satellites were established for several reasons:

1. The central headquarters building had reached capacity;
2. The work performed at these satellites does not require much contact with the central headquarters;
3. They provide an opportunity for the insurance company to gain experience in managing satellite operations.
4. They permit access to a different labor market; and
5. They aid in assessing the effects of decentralization.

The workers in the satellite offices receive a reduced package of employee benefits. Their weekly pay is \$10/employee less and there are no free lunches provided. Despite these reduced benefits, the satellites attract better qualified

personnel, as indicated in Table IV-5, which uses 1972 data. Further, the creation of these two satellite offices has allowed the insurance company to reach different labor markets and resulted in a reduced commuting distance for all levels of employees at the satellites.

E. BANKING INDUSTRY

In the banking industry, the other major information industry under consideration, both the operational characteristics and systems requirements are radically different from the insurance company. Although banking is largely decentralized (fragmented) in its customer contacts through branches, most major banks maintain large central headquarters and data processing centers to deal with the vast amounts of paper (mostly checks) that flow daily through the branch banks.

The members of the research team held a series of meetings with the Director of Management Science and the Vice President for Data processing at one of the largest California banks in order to obtain a better understanding of the industry. This bank handles approximately 1.2 million demand deposit (checking) accounts which require updating daily.

Discussions with the bank management indicated that the problems faced by the bank are far different in nature than those faced by the insurance company. Although they have approximately the same number of accounts, the insurance company has an average of one transaction per account per month, whereas the bank has an average of one transaction per account per day. Errors are

	<u>HEADQUARTERS</u>	<u>SATELLITES</u>
Ratio of number interviewed to number hired:	6 to 1	1.5 to 1
Average test scores of those hired:		
Arithmetic	5.4	6.0
Verbal	5.3	5.9
Average test scores of those interviewed but not hired:		
Arithmetic	4.0	5.3
Verbal	4.0	4.3
First year termination rate:	73%	45%
Starting salary plus benefits/week:	\$98	\$88
Productivity:	1.0	1.15

TABLE IV-5, Comparison of Satellite Offices and Headquarters Personnel

critical; they must be quickly detected and corrected. Security is very important to the bank and access to the accounts must be protected. Finally, the bank requires a one day turnaround as opposed to the three to five day turnaround considered satisfactory by most divisions of the insurance company.

The problem is further complicated by the fact that the bank is not a stand-alone organization. The paper operations of an insurance company do not depend on those of other companies; the bank, however is tied into the banking system as a whole. Thus, 45% of all checks handled by the bank belong to another major bank in the state and only 25% of their checks are for their own customers. The bank management expressed the opinion that there is no advantage in making improvements that would conflict with the rest of the system.

These considerations indicate that before decentralization of the paper handling operations of banks can be achieved, an industry-wide view of the banking systems' data processing and transportation operations would be necessary. Information would also have to be obtained on the travel patterns to individual branches to determine whether banks hire locally or whether they generate longer distance travel comparable to that of the insurance companies.

CHAPTER IV. FOOTNOTES AND REFERENCES

1. U.S. Bureau of the Census, Statistical Abstract of the United States, 1974 (Washington, D.C.: U.S. Government Printing Office, 1974), p. 379.

V. DEVELOPMENT OF A TELECOMMUNICATIONS NETWORK OPTIMIZATION MODEL

A. GENERAL MODEL

In implementing decentralization of an organization through telecommunications, two important decisions must be made: 1) the number of work centers to create, and 2) the number of employees per work center. In an actual situation, several different kinds of constraints must be satisfied when making these decisions: 1) ensuring an adequate supply of skilled labor in a particular locality; 2) meeting externally imposed constraints, such as Equal Opportunity Employment Guidelines; 3) meeting corporate policy restrictions; and 4) designing the optimum task accomplishment system to ensure maintenance or improvement of labor productivity. In meeting these constraints, the company will usually try to minimize total costs as its overall corporate goal. Typical costs to be considered are those of: telecommunications equipment, transportation, office and overhead costs, and efficiency of operation costs. An optimization model was developed (Figure V-1) as a test for analyzing the tradeoffs involved in making a telecommunications transportation substitution. This model is sufficiently general so that it can be applied to any information industry firm. It serves as the framework in assessing the economic feasibility of substituting telecommunications for physical transportation.

The model consists of five interrelated submodels. Each of the submodels represents a constraint on or a component of the

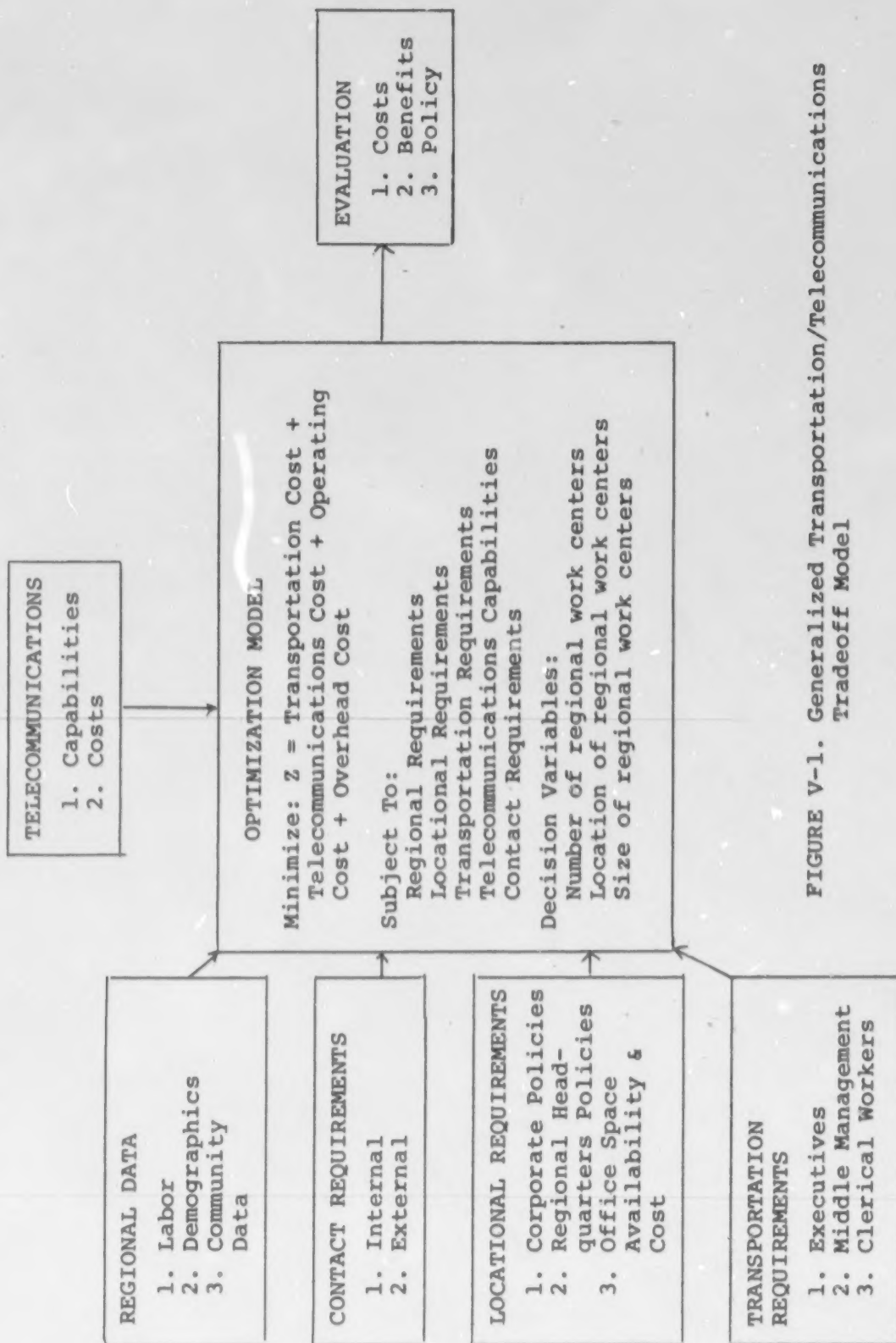


FIGURE V-1. Generalized Transportation/Telecommunications Tradeoff Model

general model. For example, detailed element lists of the regional data and contact requirements submodels are shown in Tables V-1 and V-2. Figure V-2 shows the inter-relationships of the submodels and Figure V-3 shows the relationships among the parameters of the model.

The basic concept of dispersion of a firm and its implications for transportation and communication can be illustrated by Figure V-4. The example under consideration is a major information industry firm that is located in a single, central building. The firm is a heavy user of data processing equipment and a large percentage of the employees are directly involved with clerical tasks. From a transportation viewpoint, the operation of the firm is depicted in Figure V-4A. The geographical area from which the company draws its employees has been divided into 16 approximately equal segments identified by numbers 1 through 16. The headquarters of the firm are typically in the central business district of a major metropolitan area. If the firm were to disperse its operations into four satellite offices, as shown in Figure V-4B, then the distances traveled by the employees would be considerably reduced. The only employees who would continue to report to the central headquarters and who would live at greater than usual distances from it would be some high-level executives and some specialized support services such as the Legal Department. These employees usually constitute only a small percentage of the total employee work force.

It should be noted that Figure V-4B illustrates a dispersed network, i.e., each employee would report to the center nearest

TABLE V-1. Detailed Element List

I. Labor Availability

- A. High Schools
 - 1. Number
 - 2. Enrollment
 - 3. Training Provided
- B. Total Office Employment of Region
 - 1. Insurance Companies
 - 2. Banks
 - 3. Financial Institutions
 - 4. Government Agencies
- C. Labor History
 - 1. Extent of Unionization
 - 2. Industries Unionized

II. Demographics

- A. Income Distribution
- B. Education
- C. Housing & Rental
 - 1. Availability
 - 2. Cost
 - 3. Location
- D. Age of Population
- E. Ethnic Compositions
 - 1. Black
 - 2. Spanish surname
 - 3. White
 - 4. Other

III. Community Data

- A. Police
 - 1. Personnel
 - 2. Equipment
 - 3. Incidence of Crime
- B. Fire
 - 1. Personnel
 - 2. Equipment
 - 3. Incidence
- C. Physical Facilities
 - 1. Streets & Highways
 - 2. Sewers
 - 3. Hospitals
- D. Taxes
 - 1. Rates
 - 2. Assessments
- E. Urban Mass Transit

TABLE V-2. Detailed Element List of Contact Requirements Submodel

I. Internal Contact Requirements

- A. Type of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- B. Frequency of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- C. Amount of Information Required of Contact
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer

II. External Contact Requirements - Company

- A. Type of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- B. Frequency of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- C. Amount of Information Required of Contact
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer

III. External Contact Requirements - External

- A. Type of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- B. Frequency of Contact Required
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer
- C. Amount of Information Required of Contact
 - 1. Face-to-face
 - 2. Telephone
 - 3. Letter/paperwork
 - 4. Computer

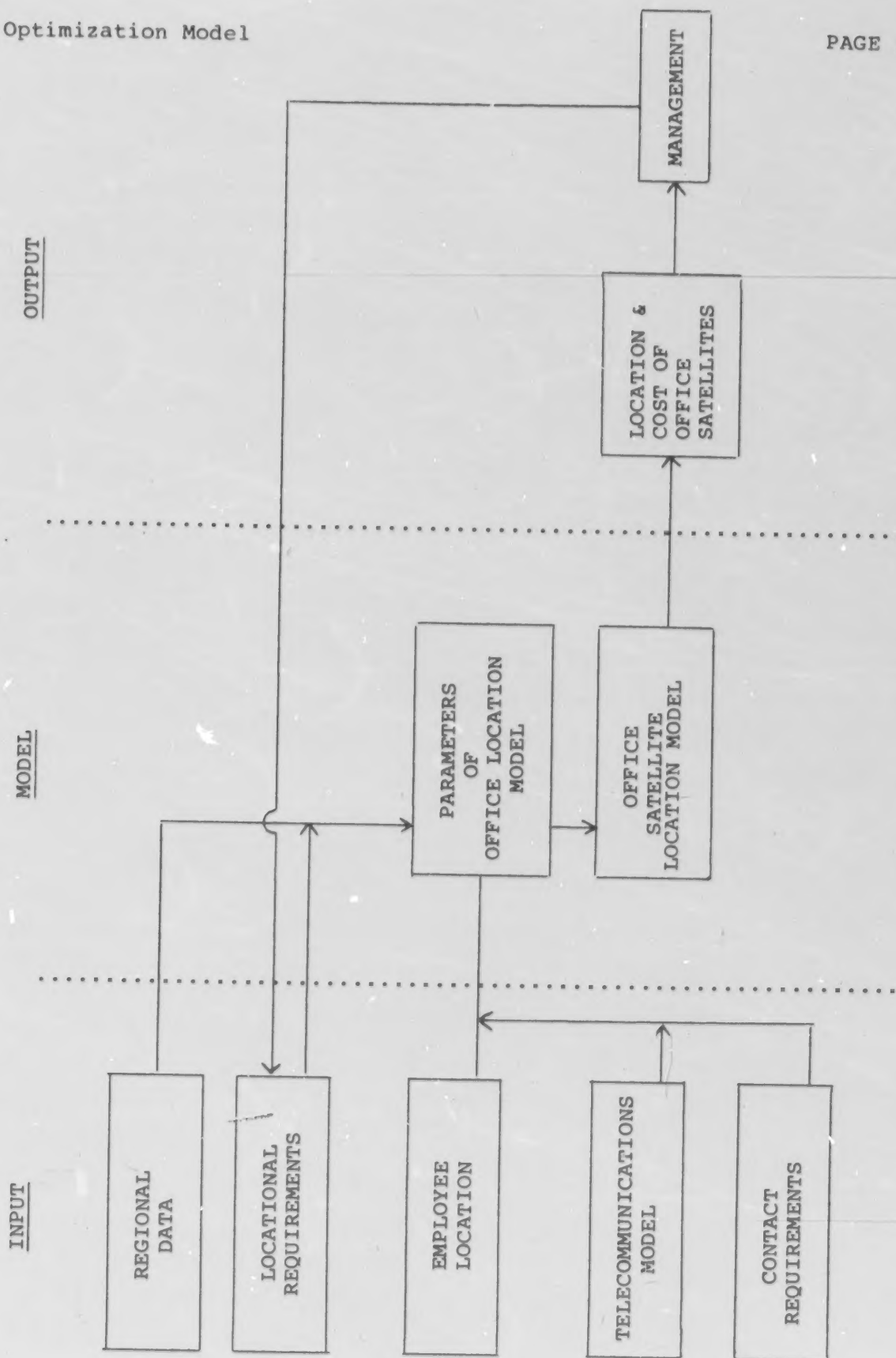


FIGURE V-2. Schematic Diagram of the Model.

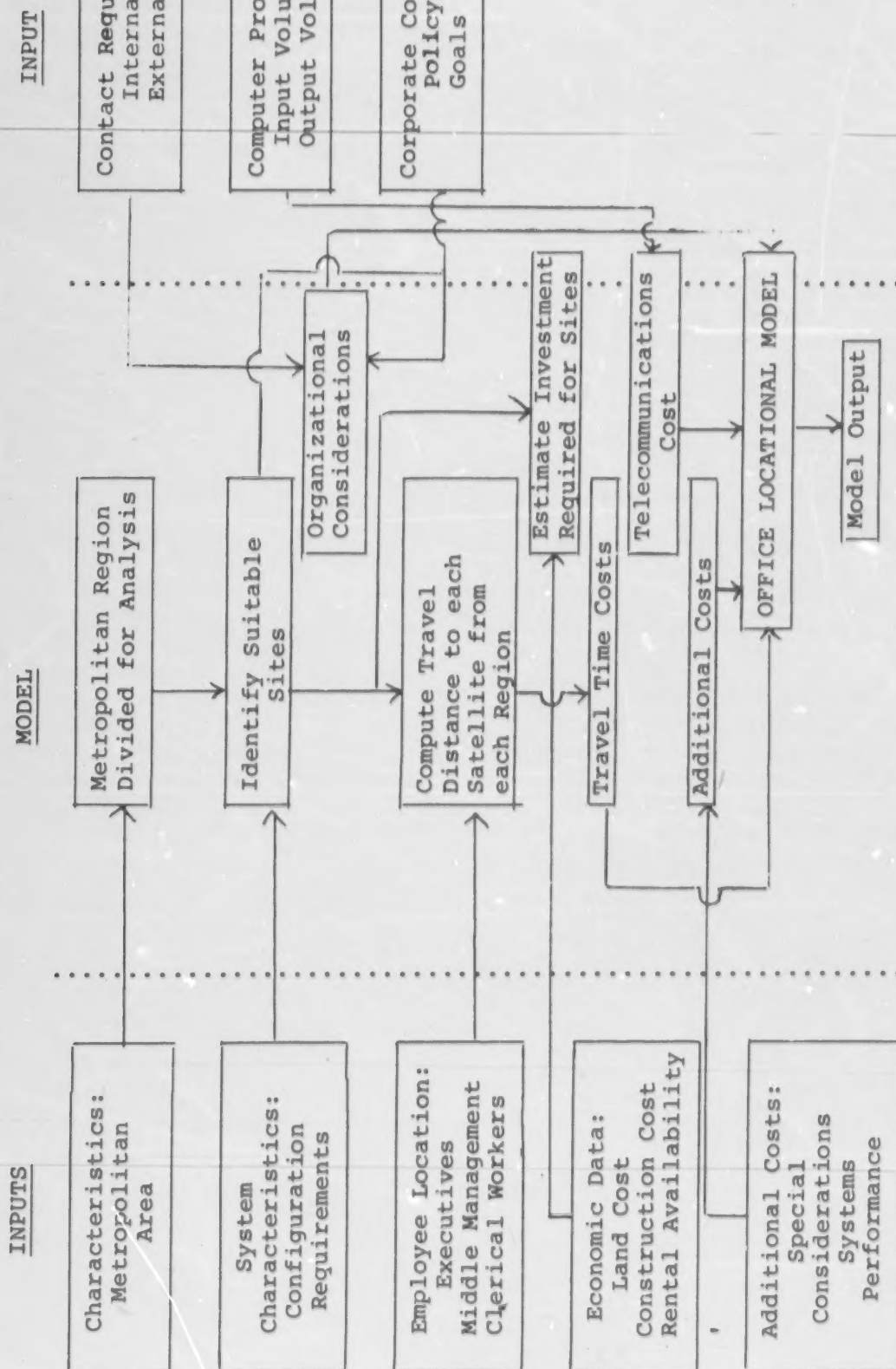
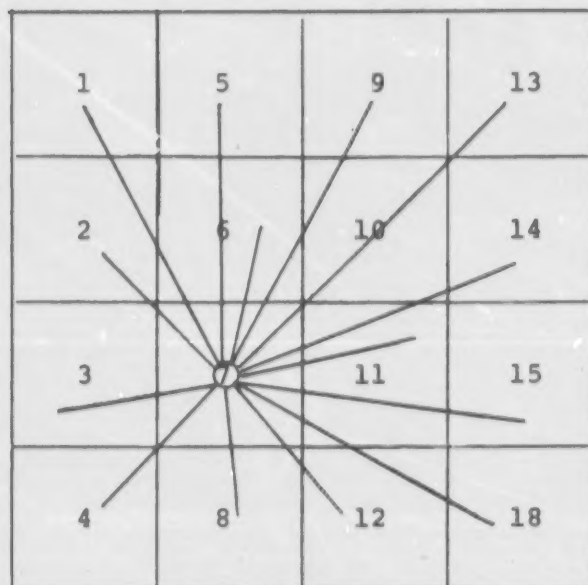
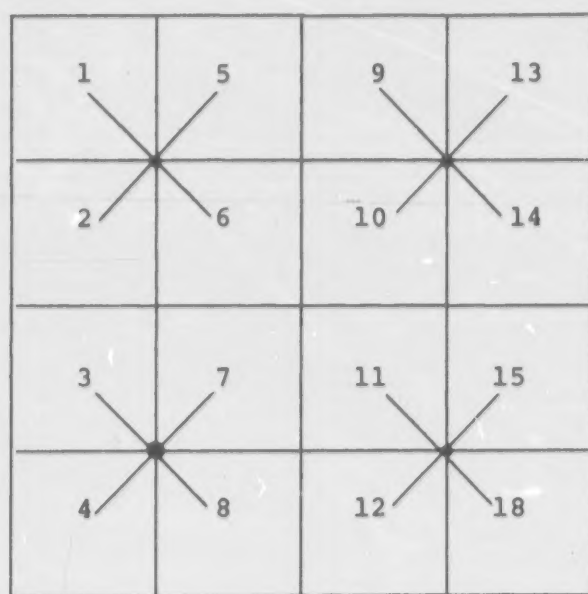


FIGURE V-3. Relationship of the Model with its Parameters



V-4a. One Central Headquarters



V-4b. Four Satellite Offices and One Central Headquarters

FIGURE V-4. Impact of Firm Dispersion on Transportation

his home, regardless of his rank or function. A fragmented network, in which the centers are specialized, could easily result in an increase in transportation if workers had to travel to a center at some arbitrary distance from their homes in order to perform their work (although this is currently the most common case of decentralization found in the U.S.).

The specific locations of the satellite offices, the number of offices, and the geographical areas assigned to supply the labor pool for the offices must now be determined. It is at this point that other cost considerations and company constraints become important.

B. COST IMPLICATIONS

The creation of satellite office locations impacts a number of costs, the primary ones being transportation, telecommunications and overhead costs. Transportation costs should decrease as more dispersed satellite offices are established. Transportation costs are a product of the average distance traveled per employee, the number of employees, and the cost per mile to commute. With the creation of additional office satellites, the transportation costs decrease, since the average distance traveled to work decreases (assuming that workers go to the nearest satellite). Telecommunications costs should increase as more satellite offices are established, but this cost is partially compensated for by reduced data rates to each satellite and a consequent reduction of the cost per satellite. Telecommunications costs include the costs of hardware and

software and data transmission. As more satellite offices are created, the telecommunications costs would rise to the extent that hardware and software would have to be provided at each site. The overhead costs are variable, depending on the circumstances of each case. Based on the insurance company's experience with its satellite offices, it appears that turnover and employee training costs decrease, along with salary costs and office space costs. High productivity at the satellite offices also lowers overhead costs. Additional office equipment and office machines and a higher inventory of supplies at the centers can result in increased costs (i.e., reduced pooling of materials and supplies, plus a minimum inventory requirement at each center which might be slightly higher than the equivalent at a central location).

C. CASE STUDY MODEL

As a preliminary step in designing a dispersion model for the insurance company, reference was made to the Los Angeles Basin Planning Document. [V-1] This document, compiled for the Los Angeles Department of City Planning, projects trends and recommends development patterns for the Los Angeles Basin to 1990. One of the key recommendations of the Planning Document was the development of 35 regional centers throughout the Los Angeles Basin and the San Fernando Valley (Table V-3). The team used these 35 regional centers to perform a preliminary computer run to calculate the commuting distance for each of the company employees to the nearest center out of 35. The company studied

TABLE V-3. 35 Regional Centers

<u>Central Area</u>	
1. Boyle Heights	
2. Central City	
3. Hollywood	
4. North & East Century City	
5. North East Los Angeles	
6. South Central Los Angeles	
7. Silver Lake	
8. South East Los Angeles	
9. West Adams	
10. Westlake	
11. Wilshire	
<u>Western Area</u>	
12. Bel Air	
13. Brentwood	
14. Palms	
15. Venice	
16. Westchester	
17. Westwood	
18. West Los Angeles	
<u>San Fernando Valley</u>	
19. Canoga Park	
20. Chatsworth	
21. Encino	
22. Granada Hills	
23. Mission Hills	
24. North Hollywood	
<u>San Fernando Valley (cont.)</u>	
25. Northridge	
26. Pacoima	
27. Reseda	
28. Sherman Oaks	
29. Sunland	
30. Sylmar	
31. Van Nuys	
32. Verdugo	
<u>Southern Area</u>	
32. San Pedro	
33. Torrance	
35. Wilmington	

provided employee residence location data by ZIP code. The employee residences were assumed to be uniformly distributed within any ZIP area. The centroids of the employee ZIP code areas (Figure V-5) were used to compute the travel distances to the headquarters. The most feasible 18 centers were selected from the original 35 (Table V-4). The average employee commute was reduced from 10.7 miles one way (the current travel distance to the single central site), to 3.9 miles one way to the nearest center (using 18 centers). The centers selected corresponded to population concentrations for current insurance company employees; the ZIP code areas in which the centers are located are shown in Figure V-6. In the following chapters, the transportation costs of the employees are calculated and compared with projected telecommunications and transportation costs for the 18 centers selected.

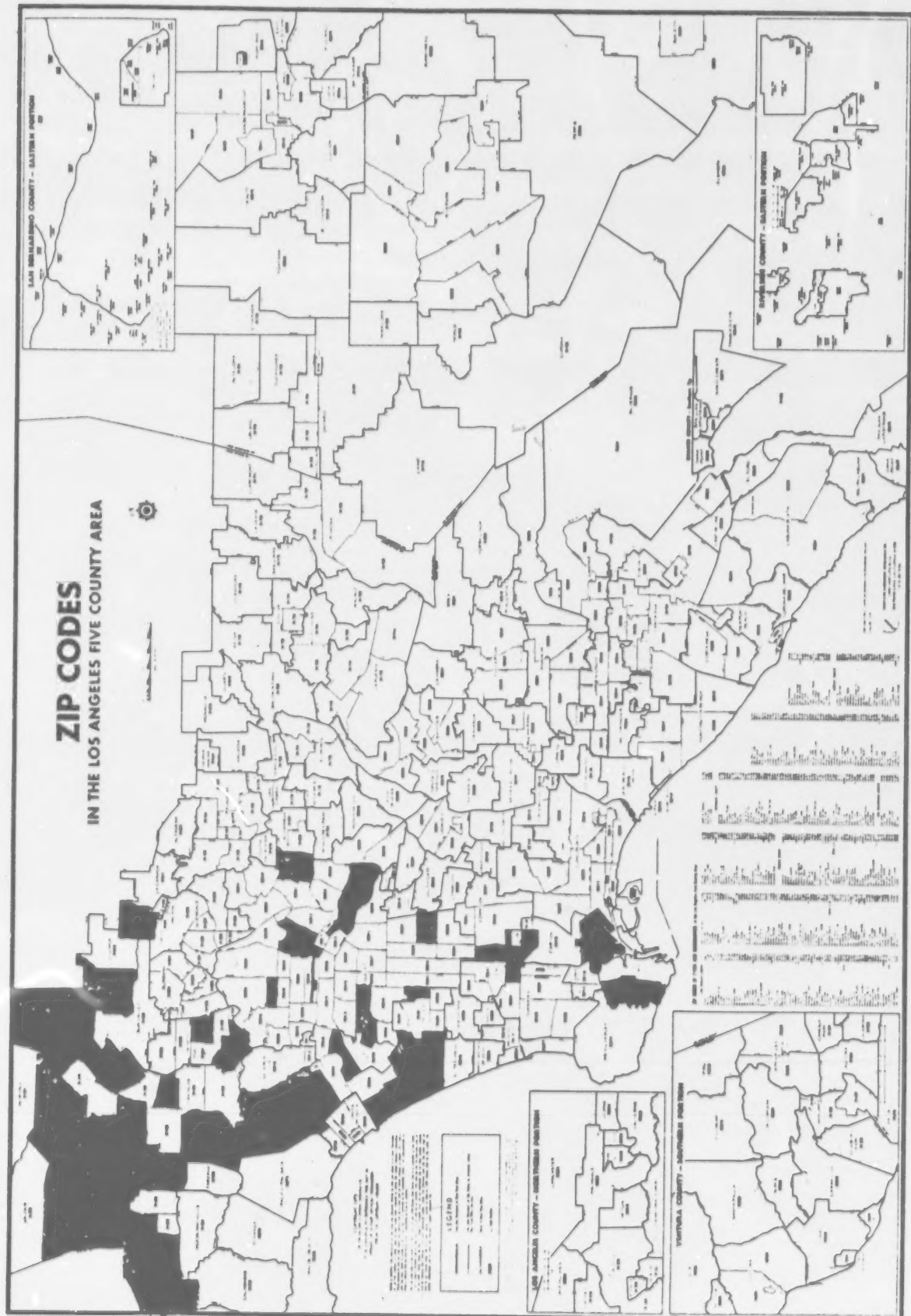


FIGURE V-5. Los Angeles Zip Code Map and IC Employee Zip Code Areas.

TABLE V-4. 18 Regional Centers

Central Area

1. Central City
2. Hollywood
3. North East Los Angeles
4. South East Los Angeles
5. West Adams
6. Wilshire

Western Area

7. Palms
8. Westchester
9. West Los Angeles

San Fernando Valley

10. Canoga Park
11. Encino
12. Northridge
13. Pacoima
14. Sherman Oaks
15. Sylmar
16. Verdugo

Southern Area

17. San Pedro
18. Torrance

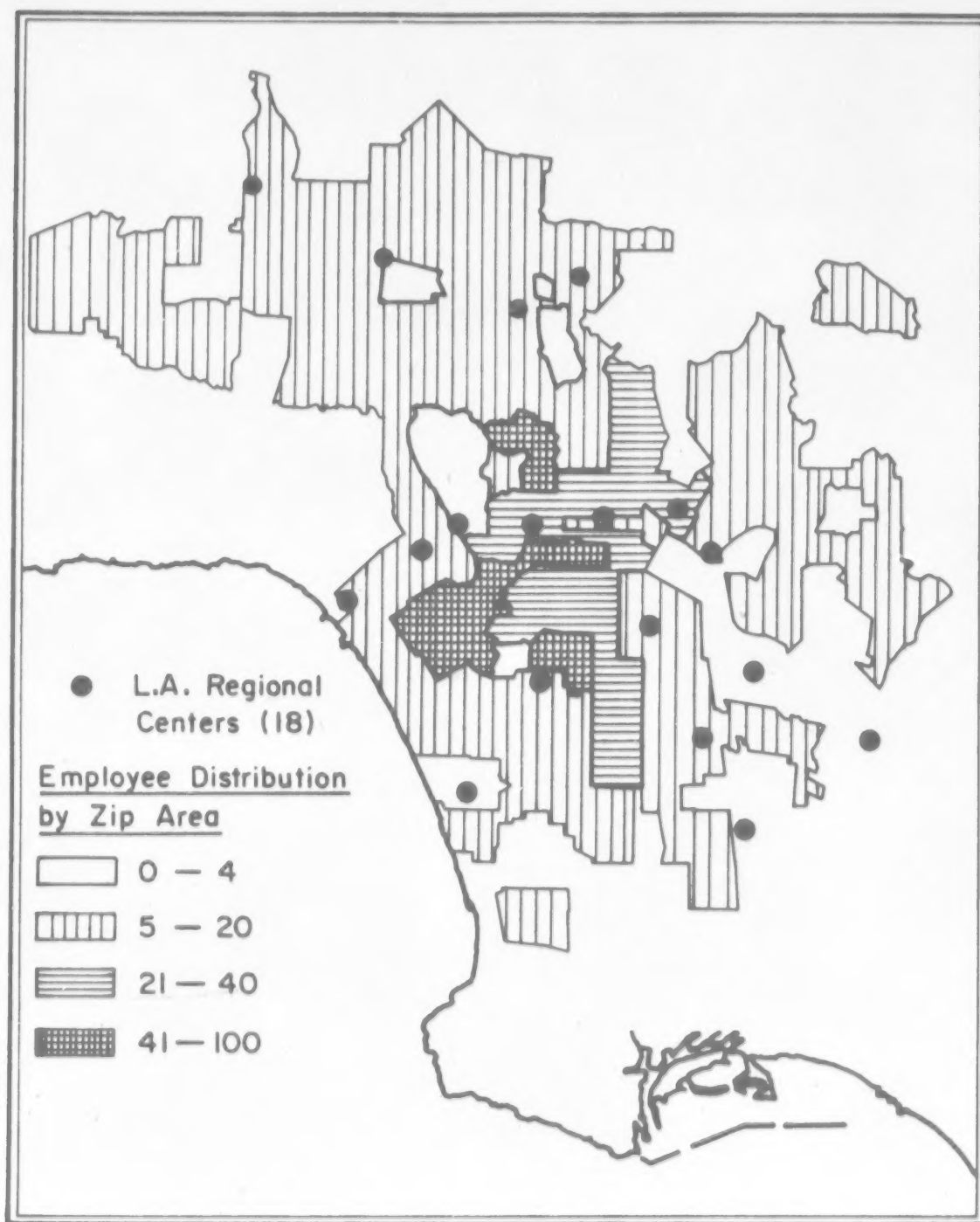


FIGURE V-6. Residential distribution of insurance company employees (number of employees residing in each zip code area). Locations of 18 urban centers specified by the Los Angeles City General Plan.

CHAPTER V. FOOTNOTES AND REFERENCES

1. City of Los Angeles, Department of City Planning, "Planning Area 1990: Population, Housing and Employment Projections," 1974.

VI. GENERAL TELECOMMUNICATIONS NETWORK CONSIDERATIONS

A. INTRODUCTION

The main objective of this portion of the study was to determine the feasibility of implementing a telecommuting system in place of the common, hub-oriented transportation system. For purposes of policy formulation, both private and public networks were considered. The commuting distances of the personnel at the insurance company and the general information requirements of the insurance company were used to formulate a hypothetical network configuration. Several sets of alternative requirements were postulated to determine cost impacts. An analysis was made of the human factors involved in the design of a telecommunications network of the type envisioned and, as part of this analysis, a series of scenarios were developed to illustrate the relationships between the human factors and technological requirements of alternative networks. In all cases the costs of the network were estimated conservatively.

The hypothetical network configuration was based on the establishment of 18 regional centers such as those discussed in Chapter V. These centers are major areas of population and/or commerce within the Los Angeles Basin; they constitute the basis for a baseline estimate of the practical possibilities for near term dispersion. Since the insurance company's central office is located near the central business district of Los Angeles, a simple star communications network would suffice to serve the

regional centers. The postulated network radiates from the site near the present corporate offices where the main computing system would be located.

In calculating the costs of the network, it was assumed that the cost of acquiring the remote site real estate and facilities would be less than, or at most equal to, costs of maintaining the downtown facility of 2500 employees. This assumption is based on the premise that the costs of construction would be offset by the appreciated value of the real estate in central Los Angeles and on the fact that office space in the central business district currently sells for a high premium cost relative to the average costs of real estate at the regional center locations (cf. Chapter IX). Further, it was assumed that the building or rental costs of the remote facilities would not be sufficiently increased by the installation of terminals and remote computing equipment and the increased loads on air-conditioning and other facilities. Our experience with the design of buildings which house computerized office environments, such as the Information Sciences Institute at the University of Southern California, leads us to believe that this is a reasonable assumption.

Another critical assumption is that the data rates (which we have estimated from data rates associated with the current computing rates at the insurance company) would not increase by an order of magnitude. Currently, the insurance company processes a very large amount of data utilizing computer equipment. This processing does not represent the entire workload for every employee within the insurance company. However, it does represent

a significant portion of the volume of work accomplished by the clerical personnel who would be dispersed. It is clear that there would be an increased load on the telecommunications system as a result of additional interoffice memoranda and other associated managerial tasks such as monitoring of clerical personnel through the telecommunications system.

The network design for a "worst case" would be the allocation of a terminal to every dispersed employee. Present computer usage requirements could be satisfied by one terminal for every five to thirty employees, depending on the particular work pattern. If the system does not allocate one terminal per employee, there is a further need to account for queuing problems. Queuing is essentially a function of terminal use, i.e., if there is less than one terminal per employee at each site, then some period of time conceivably could be spent by employees waiting for terminals to become available. The queuing problem cannot be answered explicitly without knowledge of the mean arrival time of employees requesting service at terminals. We have not yet gathered information to this level of detail; however it is reasonable to expect that no significant queuing would occur with one terminal per five employees.

A final assumption was made that an audio bandwidth system would be used. This assumption was based on analysis of the functions of the Issue and Underwriting Divisions of the insurance company (cf. Chapter IV). This analysis indicated that the functions of these divisions could be performed at remote locations using an audio bandwidth telecommunications system.

This point is critical, since a network designed for audio bandwidths influences other features of the system and means that a less user-specific system is necessary. This latter point is also particularly important since it permits a wider applicability of the research findings.

B. PRIVATE NETWORK

1. Assumptions

Before discussing the costs of the private network, it is necessary to review the basic design and cost assumptions. As indicated in Chapter V, 18 regional centers were selected. In our hypothetical network design, site 4 would be the central site and, as such, would house the main computer. This site would be located three tenths of a mile from the current central site.

The 18 centers provide a reasonable reduction of commuting distance for the insurance company employees without increasing the costs of the telecommunications network beyond reasonable limits. The primary cost assumption for the private network was that each center would be linked with the main computation center via a coaxial cable installation. A coaxial cable installation was chosen because of the ability to have a major expansion in data volume without requiring new transmission lines. Given the assumption that the centers would be hard-wired to the computer in the focal location, it was necessary to estimate the installation costs of the coaxial cable. This task was difficult since the costs associated with the installation of coaxial cable vary considerably. Depending on where and how the cable is

installed, the cost can be as high as one million dollars per mile. The variance in installation costs is due partly to local ordinances which prohibit exposed wiring and the cost of digging up streets in different areas. Lower costs per mile are possible in those areas where it is possible to use above ground installation techniques such as the common "telephone pole" installation. For example, to trench down Fifth Avenue in midtown Manhattan would be considerably more expensive than stringing cable on telephone poles through a residential area. It is important to note that, except in those areas where installation costs would be extremely high, the cable installation represents a relatively small portion of the total cost. For example, the total length of intercenter cable in our hypothetical network was 205 miles. At \$3,000 per mile (the estimated average installation cost for our network), the installation cost would be \$615,000, or 9% of the total network cost. Even if the cost of installation were doubled (\$6,000 per mile), installation would represent only \$1,230,000, or 16% of the total network cost. Even these percentages give distorted pictures of the relative costs since the proposed cable network would have a data capacity far in excess of that used for estimating the other costs.

To add this other dimension to the installation cost, it should be noted that if the maximum number of employees in a single center is, for example, 230, and even if only one strand of coaxial cable is pulled to each center, then a significantly higher bandwidth for data transmission is available than is necessary. Assuming, for the 230 employee case, that each

terminal were operated at 2,400 baud, with one terminal per employee, one voice grade line per terminal would be required. If a 150 megaHertz bandwidth is assumed for the coaxial cable, then approximately thirty thousand two way 2,400 baud lines could be multiplexed into it (assuming no other use of the cable). This is a factor of 120 greater than the number of employees at even the largest center in our hypothetical network.

The \$3,000 per mile cost mentioned above for our hypothetical network represents the estimated average cost of installing coaxial cable in the Los Angeles area; the figure was determined through discussions with several cable television consultants and includes allowances for incremental installation. Incremental installation means that costs are shared between the installer of the cable and one or more public utilities. For example, when the cable must be buried, a trench of six feet or more would be dug down the center of the road. Five feet of the trench would belong to the public utilities (e.g., power, sewer, gas and water) and one foot would belong to the installer of the cable.

There is a fixed cost at each center associated with the installation of the telecommunications system. That fixed cost includes the cost of a high speed line printer, an input-output controller or multiplexer, and additional space and power requirements. If we assume that each center uses a fairly sophisticated high speed line printer, the fixed cost per center would be approximately \$120,000. A line printer was included for each center on the assumption that hard copies of data files

would be needed from the central computer location. The need for hard copies would be dependent on the data needs of the employees at each center. To determine these needs, it would be necessary to know a) the dispersion of employees, broken down by work function, to the 18 centers, and b) the need for each employee at each center for hard copies of the central data files. Lacking this information, a simple assumption was to include one high speed printer per center. While this is a "worst case" analysis, it is also reasonable to expect that larger centers might require several line printers while other locations might not require any.

The cost of the terminal was estimated at several levels, primarily to show the impact of the terminal cost upon the total network cost. The simplest terminal would be the teletype variety, with an approximate purchase price of \$1,100, although significant reductions in cost would be possible with bulk purchasing. The most expensive terminal, which would cost approximately \$5,000 would be a sophisticated, semi-intelligent terminal with on-line editing and formatting capabilities. A mix of terminals would be most probable with the mix being designed to specifically meet the needs of the employees at each site. It is quite possible, judging from the experience of USC's Information Sciences Institute, that a large number of these would be CRT terminals. This step would eliminate a large fraction of actual paper work. Cost savings from these paperless transactions are not included in these estimates.

In summary, the cost of installation of coaxial cable is

estimated at \$3,000 per mile. The fixed cost per center is approximately \$120,000. The cost per employee is essentially the cost of the terminal and its maintenance divided by the number of employees per terminal. There is a small facilities increase associated with wiring each work station for terminal access, but it is assumed that this cost would be absorbed in construction or rental of the facility.

2. Hypothetical Private Networks

The 18 centers produce the dispersed network design shown in Figure VI-1, with the computer being housed at the central site. In this section, five hypothetical cases will be presented for the 18 center configuration and one hypothetical case will be given for a 35 center configuration. The section concludes with an 18 center configuration and network design that assumes fewer terminals and calculates capital and maintenance costs as they would be incurred by the insurance company studied. In cases I, II, III and VII the following assumptions were made:

1. The 18 centers are the same in each case;
2. The fixed cost per center is \$120,000;
3. The installation cost of the coaxial cable is \$3,000 per mile;
4. The total number of miles in the network is 205;
5. The cost of paper associated with the computer terminals is approximately the same as the cost of paper used by the employees now;
6. Hard copy would be available through the line printer at each center;
7. One terminal per employee would be provided for the 2,048 employees who hold clerical and middle management positions; and
8. The basic capital costs do not include amortization or maintenance charges.

The variable factor in the first three cases is the cost per

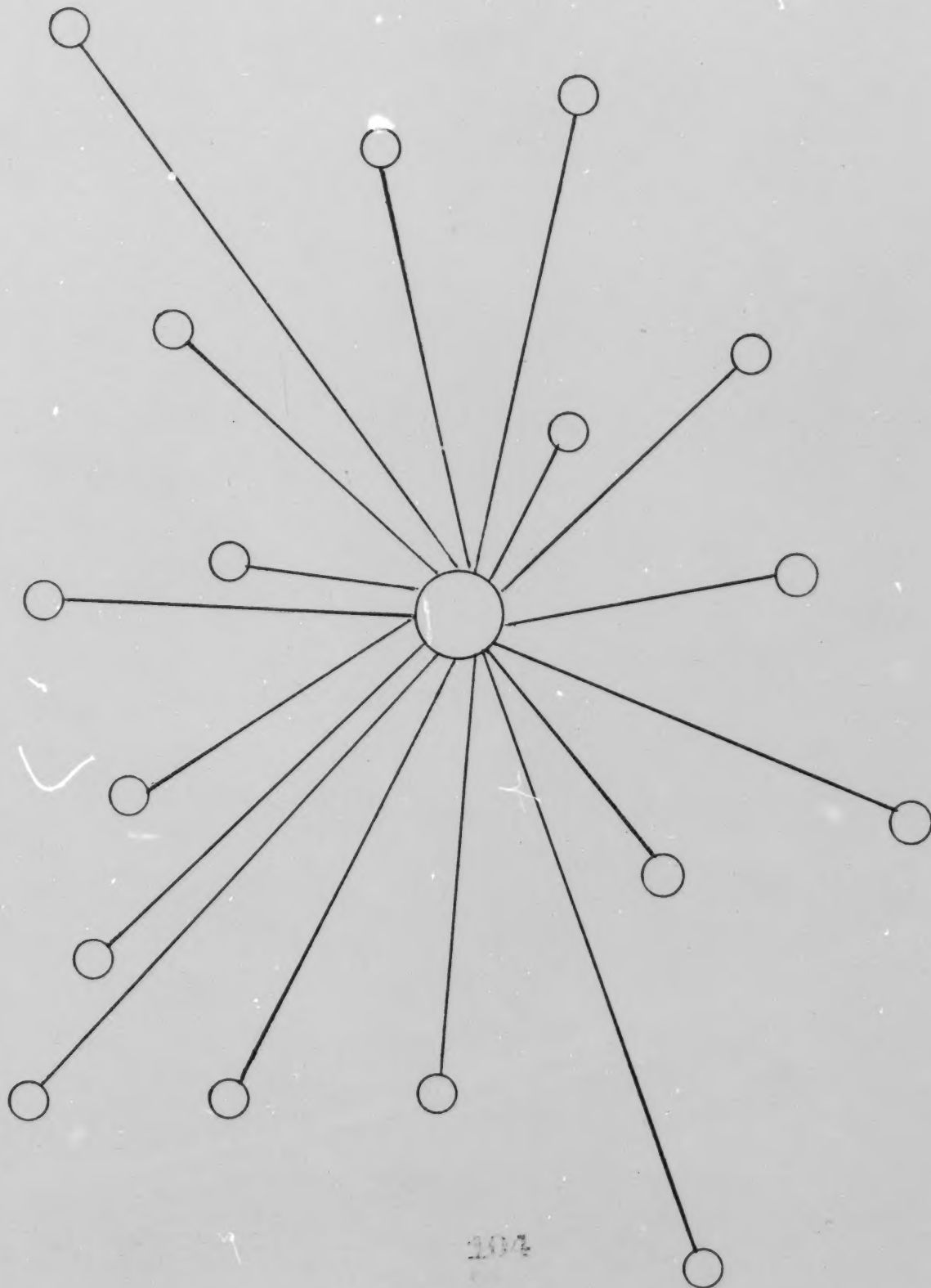


FIGURE VI-1. 18 Center Network Design

employee, i.e., the cost of the terminal.

In Case I, the terminal cost is set at an average of \$2,000, which would bring the total network cost to approximately \$6,872,000. In Case II, the network cost is reduced to \$5,029,000 by postulating a cheaper terminal that would cost \$1,100. Case III is based on an assumed terminal cost of \$5,000, representing a highly sophisticated terminal. Use of these more expensive terminal would bring the total network cost to approximately \$13,016,000. Cases I through III are summarized in Table VI-1. It is clear, from these cases, that the principal factor in the total costs of the hypothetical network is the number and type of terminals used by the employees, at least in cases of high terminal population.

In Case IV (Table VI-2), an alternate selection of 18 centers was made, which changed the total network miles slightly. However, the other assumptions given for Cases I through III remain the same. The average cost of \$2,000 per terminal was again used as a basis for calculation. The network cost in Case IV was approximately \$6,868,000 (as compared to \$6,872,000 for Case I), indicating that the cost of the network is relatively insensitive to the details of the location of the centers, assuming that the selection is at all "reasonable."

Although, in Los Angeles, microwave channels are already overloaded, the possibilities of microwave or optical point-to-point links were explored for comparison purposes. In Case V, the assumption was made that an infrared communications link, rather than cable, would be established between the original 18

NODE	MILES FROM CENTRAL	NUMBER OF EMPLOYEES AT NODE	\$ COST OF NODE (CASE I)	\$ COST OF NODE (CASE II)	\$ COST OF NODE (CASE III)
1	11	114	\$382,000	\$279,000	724,000
2	7	59	259,000	206,000	436,000
3	4	128	387,000	271,000	771,000
4	0.3	230	581,000	374,000	1,271,000
5	4	121	373,000	164,000	736,000
6	7	129	399,000	283,000	786,000
7	4	211	553,000	363,000	1,186,000
8	13	214	587,000	395,000	1,229,000
9	23	102	394,000	302,000	700,000
10	11	64	281,000	224,000	473,000
11	17	46	265,000	224,000	403,000
12	4	109	350,000	252,000	677,000
13	8	197	539,000	362,000	1,130,000
14	11	118	388,000	282,000	742,000
15	17	63	298,000	241,000	487,000
16	21	63	310,000	253,000	499,000
17	20	25	229,000	207,000	304,000
18	22	55	297,000	248,000	462,000

COST PER CENTER: \$120,000
COAXIAL CABLE INSTALLATION COST/MILE: \$3,000

NUMBER OF EMPLOYEES: 2,048

TERMINAL COST (ONE PER EMPLOYEE):

CASE I: \$2,000

CASE II: \$1,100

CASE III: \$5,000

TOTAL COST OF NETWORK:

CASE I: \$ 6,872,000

CASE II: \$ 5,029,000

CASE III: \$13,016,000

AVERAGE COMMUTING DISTANCE (ROUND TRIP): 7 MILES

TABLE VI-1. NETWORK COSTS FOR CASES I, II AND III

<u>NODE</u>	<u>MILES FROM CENTRAL NODE</u>	<u>NUMBER OF EMPLOYEES AT NODE</u>	<u>\$ COST OF NODE (CASE IV)</u>
1	12	62	\$280,000
2	8	49	241,000
3	3	326	782,000
4	13	120	399,000
5	10	179	507,000
6	6	72	383,000
7	13	97	352,000
8	5	256	447,000
9	3	202	532,000
10	4	171	475,000
11	11	106	365,000
12	11	47	246,000
13	7	88	317,000
14	28	39	281,000
15	27	19	240,000
16	10	118	386,000
17	19	59	296,000
18	15	138	440,000

COST PER CENTER: \$120,000

COAXIAL CABLE INSTALLATION COST/MILE: \$3,000

NUMBER OF EMPLOYEES: 2,048

TERMINAL COST (ONE PER EMPLOYEE): \$2,000

TOTAL COST OF NETWORK: \$6,868,000

AVERAGE COMMUTING DISTANCE (ROUND TRIP): 3.4 MILES

TABLE VI-2. NETWORK COSTS FOR CASE IV (18 DIFFERENT SITES)

centers. The infrared link used (assuming "off-the-shelf" technology) does not have the cable's capacity of 150 million bits per second, but it could easily have a capacity in the order of 100 kilobits. One hundred kilobits bandwidth would still support approximately 35 employees, based on a rate of 2,400 baud (20% guard bands). With a terminal mix that used a significant number of terminals that were capable of 30 characters per second, the number of employees which could be supported would increase by a factor of eight. This would yield a maximum number of employees per center of approximately 280, or fifty more employees than the largest center postulated.

Instead of using a cable cost per mile, as in the previous cases, we increased the cost per center by \$120,000, postulating the point-to-point links for center interconnect. Other network assumptions remain the same. The cost per center estimate is questionable because if many centers were to be equipped, then it would only be possible (because of spectrum crowding problems) to design point-to-point communications technologies based on modulated signals transmitted at or near the frequency of light. In Los Angeles, where dense fog and smog are frequent enough to be a consideration, repeater stations would be required on the longest point-to-point communications links. Nevertheless, we felt that \$240,000 per center was approximately correct. It was interesting to note that the cost of the network, compared to Case I, increased by approximately 1.6 million dollars (Table VI-3). It should also be noted that with the probable advent of low cost optical fiber transmission systems in the next decade,

<u>NODE</u>	<u>MILES FROM CENTRAL NODE</u>	<u>NUMBER OF EMPLOYEES AT NODE</u>	<u>\$ COST OF NODE (CASE V)</u>
1	11	114	\$468,000
2	7	59	358,000
3	4	128	496,000
4	0.3	230	700,000
5	4	121	482,000
6	7	129	498,000
7	4	211	662,000
8	13	214	668,000
9	23	102	444,000
10	11	64	368,000
11	18	46	332,000
12	3	109	458,000
13	8	197	634,000
14	11	118	476,000
15	17	63	366,000
16	21	63	366,000
17	20	25	290,000
18	22	55	350,000

COST PER CENTER: \$240,000

COST/MILE: \$0.0

NUMBER OF EMPLOYEES: 2,048

TERMINAL COST (ONE PER EMPLOYEE): \$2,000

TOTAL COST OF NETWORK: \$8,416,000

AVERAGE COMMUTING DISTANCE (ROUND TRIP): 7 MILES

TABLE VI-3. NETWORK COSTS FOR CASE V (INFRARED
COMMUNICATION LINK)

enormous gains in bandwidth capability between centers will be possible at a relatively stable cost of installation. Hence, the point-to-point system does not appear to be very feasible.

Case VI (Table VI-4) is a recalculation of Case I using the 35 centers of the Los Angeles Planning Document instead of the 18 centers used in the previous cases. The cost and design assumptions are the same as those given for Case I. The approximate cost of a 35 center network would be \$9,736,000, an increase of approximately \$3 million over Case I, although the average employee round trip commute distance would decrease by only 1.4 miles with the addition of 17 more centers. This observation indicates that the decrease in commuting miles beyond the 18 center point, although representing an annual cost saving to each employee of about \$50 (an annual total for employees of \$125,000) would not justify the increase in either administrative or capital costs of the larger telecommunications network.

In Case VII, we reduced the number of employee who would be working with terminals to 1,800 (i.e., clerical employees only) and attempted to calculate the costs as they would actually be incurred by the insurance company. Thus, rather than assume a one-time cost, we amortized the cost to the insurance company over a five year period at 10% interest. However, since amortization is frequently done over a seven to ten year period by the computer industry, calculations were also done for the longer amortization period. A "worst case" situation was assumed, with no resale value being allowed at the end of the amortization period. A moderately high terminal cost of \$2,500 was assumed,

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<u>NODE</u>	<u>MILES FROM CENTRAL NODE</u>	<u>NUMBER OF EMPLOYEES AT NODE</u>	<u>\$ COST OF NODE (CASE VI)</u>
1	12	61	\$278,000
2	8	35	213,000
3	3	326	782,000
4	9	15	176,000
5	13	101	361,000
6	10	135	419,000
7	6	56	251,000
8	13	55	268,000
9	5	156	447,000
10	5	15	166,000
11	3	202	532,000
12	7	0	142,000
13	11	12	176,000
14	4	171	475,000
15	11	106	365,000
16	11	38	228,000
17	7	11	164,000
18	7	65	271,000
19	28	39	281,000
20	27	10	222,000
21	15	17	198,000
22	24	9	210,000
23	19	16	209,000
24	10	88	326,000
25	22	8	201,000
26	18	13	201,000
27	19	34	246,000
28	7	33	208,000
29	18	9	191,000
30	22	5	197,000
31	14	81	326,000
32	17	31	234,000
33	29	5	216,000
34	19	69	315,000
35	27	21	242,000

COST PER CENTER: \$120,000
 COAXIAL CABLE INSTALLATION COST/MILE: \$3,000
 NUMBER OF EMPLOYEES: 2,048
 TERMINAL COST (ONE PER EMPLOYEE): \$2,000
 TOTAL COST OF NETWORK: \$9,736,000
 AVERAGE COMMUTING DISTANCE (ROUND TRIP): 5.6 MILES

TABLE VI-4. NETWORK COSTS FOR 35 CENTERS (CASE VI)

allowing for a fairly sophisticated terminal. The same installation and center costs were assumed along with the original 18 centers.

Three alternative terminal investments were calculated. In option A, a total of 1,800 terminals was assumed (one for each clerical employee) for a total terminal cost of \$4,500,000. In option B, two employees per terminal were assumed (900 terminals at \$2,500 each) for a total terminal cost of \$2,160,000. Five clerical workers per terminal were assumed in option C, for an a total of 360 terminals costing \$900,000.

The annual amortized capital cost per employee for each of the three terminal options was calculated, for both the five and ten year amortization periods. The annual system maintenance cost per employee were also estimated in Case VII. Finally, the gross annual network cost per employee was calculated for the total insurance company population of 2,500, again considering the three terminal options over the two amortization periods.

The summary of this analysis is presented in Table VI-5. These calculations indicate that the average annaul cost per employee, would range between \$270 and \$425, depending on the assumptions used. Thus, in the best case, we have a cost that is well below the lower scale of the costs of commuting (cf. Chapter VII) and, even in the worst case, below the costs calculated at the higher end of the commuting scale (approximately \$1,100). While the dollar and energy costs of telecommuting, as compared to commuting, will be discussed in more detail in Chapter VII, some initial observations may be made. One, commuting costs

ASSUMPTIONS:

- NUMBER OF NODES: 18
 AVERAGE COMMUTING DISTANCE (ROUND TRIP):
 - CURRENT (SINGLE CENTRAL LOCATION: 21.4 MILES
 - DISPERSED: 7.0 MILES

FIXED INVESTMENT FOR PRIVATE NETWORK INSTALLATION: \$2,775,000
 - INTERFACE COMPUTER HARDWARE (@ \$120,000/NODE): \$2,160,000
 - INTERNODAL CABLE INSTALLATION (@ \$3,000/MILE) \$ 615,000

VARIABLE INVESTMENT FOR COMPUTER TERMINALS (@ \$2,500 EACH):
 A. 1800 TERMINALS (ONE PER CLERICAL EMPLOYEE): \$4,500,000
 B. 900 TERMINALS (TWO CLERICAL WORKERS PER TERMINAL): \$2,250,000
 C. 360 TERMINALS (FIVE CLERICAL WORKERS PER TERMINAL): \$ 900,000

ANNUAL AMORTIZED CAPITAL COST PER EMPLOYEE:*

<u>5 Year Amortization</u>	<u>10 Year Amortization</u>
A. \$770	A. \$470
B. \$530	B. \$330
C. \$390	C. \$240

ANNUAL SYSTEM MAINTENANCE COSTS PER EMPLOYEE (EST.)

A. \$160 B. \$80 C. \$30

GROSS ANNUAL NETWORK COST PER EMPLOYEE:*

<u>5 Year Amortization</u>	<u>10 Year Amortization</u>
A. \$925	A. \$630
B. \$610	B. \$405
C. \$420	C. \$270

*Equal annual payment method, 10% interest, 2,500 employees, rounded to nearest \$5.

TABLE VI-5. DISPERSED TELECOMMUTING NETWORK COSTS
 WITH MAINTENANCE, AMORTIZATION.

probably will continue to rise as the costs of materials, labor and gasoline continue to contribute to rising costs of automobile production and operation. Purchase costs of telecommunications and computer equipment, on the other hand, may be expected to decrease slightly as sales volumes continue to increase and the technologies improve. Operation costs, of course, can be expected to rise for both automobiles and communications equipment as energy continues to become scarcer and more valuable. However, since the operating energy consumption of telecommunications hardware is considerably lower than that of transportation systems, the impact of those higher prices will not be as significant.

C. PUBLIC NETWORK

The cost of using a public network was estimated as an alternative to a private network. The primary points of interest were:

- a) the cost to the insurance company of leasing lines from a public utility, as opposed to the cost of private cable installation, and
- b) the capability of the public network.

The baseline assumptions were the same as for the private network: 18 centers, a central computer, a terminal cost of \$2,000, and a center cost of \$120,000.

The leasing costs that would be incurred by the company were based on standard rate charges associated with a common carrier in Los Angeles. An initial estimate was made based on the costs

of voice grade, full duplex lines interconnecting each terminal in the centers and the central computer. This cost was prohibitive and was discarded.

A second estimate was based on the installation of two, fifty kilobit lines to each of the centers, using a concentrator to convert twenty full duplex 2,400 baud lines to two 50 kilobit lines. The installation of the two kilobit lines to the centers would require a one-time charge of \$35,000. The annual lease charges for the line use would be approximately \$409,000. The leased line charge is more expensive when compared to the amortized costs of the coaxial cable installation. The annual payment for coaxial cable installation, amortized over a 10 year period at 10% interest, would be \$100,000. Over five years, the annual payment would be \$162,000 and, by the end of the amortization period, the cable would be owned by the company.

The leased line would have a much lower bandwidth capacity, offering only a 100 kilobit capability as opposed to the 150 megabit capability that is possible with the coaxial cable. Also, it should be noted that the higher bandwidth capacity of the private network raises the possibility of cost sharing with other dispersed companies.

However, the public network does offer some advantages to the insurance company. The leased line would not tie the company to a longterm investment, especially during a period of rapid technological change in the communications field. Also, under the lease agreement with the public utility, the company would not incur additional maintenance charges, whereas such charges are

probable with the private network. On the basis of these latter considerations, it must be concluded that the public network represents a viable alternative to a private network using coaxial cable.

D. HUMAN FACTORS

The ability of workers to interact successfully with telecommunications equipment is largely a human factors concern. Unfortunately, very little research has been done on the human factors involved in the use of such technology by clerical workers; most studies are directed toward managerial use of telecommunications [VI-1, VI-2, VI-3]. The following section will discuss some of the human factors that should be considered in the use of telecommunications by clerical workers..

1. Job Satisfaction/Turnover

One major consideration that can seriously impact costs and productivity is job satisfaction and turnover. The reasons behind job satisfaction are a composite of human factors variables: anxiety, depression, ability to perform assigned tasks, the presence of friends, perceived antagonisms, pleasant working conditions, etc. The impacts of the worker's feelings, attitudes and perceptions, both on the individual and the group, are difficult to assess, being only partially reflected in productivity and job turnover. The impact of a telecommunications system, and the importance of this impact, have never been demonstrated. However, some related studies, albeit informal ones, have isolated some of the effects which need to be

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anticipated and measured by an organization that is contemplating changeover to a telecommunications mode.

In two major east coast financial institutions, personnel were transferred from manual methods of coding to limited computer communications systems (primarily input). Preliminary case data suggest that as a result of this transfer, there was a decline in group morale, release and transfer of older personnel increased, and turnover among young personnel was high. Four major factors were isolated;

a. Asking employees to travel to the central organization to perform routine tasks on a machine quickly alienated the affected individuals.

b. To alleviate the decline in morale and to keep turnover rates acceptable, significantly higher monetary incentives were necessary.

c. Older employees, who tended to rely more heavily on interpersonal demonstrations of productivity, were intimidated by computers which made objective measurements of their output.

d. Some older, clerical level employees were unable to adapt to man/machine relationships and had to be transferred.

To counteract this negative impression, it is interesting to note that the insurance company employees who were trained in the use of CRT terminals prior to transfer to the satellite offices (cf. Chapter IV), have evinced a high level of enthusiasm for working in this new mode. In fact, the company has encountered the problem of a "status symbol" effect, i.e., workers whose work loads do not justify the expense of a terminal are also requesting terminals, presumably on the basis of a high level of positive response and motivation.

The disparity between the employee attitudes in the first

and second instances suggest that training, organizational attitudes and orientation may be critical factors in system design. Certainly, the initial baseline measurements should be carefully designed to determine the possible presence of negative attitudes. The system design should then be accommodated to counter such attitudes.

This observation may be further supported by the experience of the USC Information Sciences Institute (ISI). At ISI, clerical employees are trained to use CRT terminals and learn to interact with the ARPA/TENEX system. Computer-naive staff are trained under the supervision of sophisticated computer science personnel for a period of approximately 6 months. The learning atmosphere is very positive, since organizational norms are highly supportive of computer terminal communications. Consequently, ISI has experienced a relatively low turnover of clerical personnel and high morale among the clerical personnel.

2. User Acceptability of the Man-Machine Interface

User acceptability of the CRT or teletype terminal in central data base communications is also dependent on software support. Software support determines the ease with which stored data is found and the way in which it is represented in display. What the software support generates during turnaround interludes and how much closure it offers users in confirming acceptance of their inputs will affect acceptability.

Languages used in the computer network can vary in their similarity to natural languages and hence the degree of training

users must have to understand and use them. The extent to which the languages are "natural" (through training or similarity to English) will affect acceptability. The extent to which the user understands the network itself will also affect acceptability.

Terminal configuration, the location of terminals relative to the central data base, line use, availability of terminals, and user information services are all relevant factors in the work environment in terms of their effects on user acceptability.

3. Scenarios

To obtain a better understanding of both human factors and technological requirements for the postulated network, a series of scenarios (Appendix III) were developed by the research team. The scenarios are summarized in the following section and the technological requirements for each system postulated are noted in Figure VI-2.

The scenarios envisioned workers in various types of telecommunications environments. The technology needed in those systems was then defined. The first scenario, "Asynchronous Managerial Conferencing," pictures the use of CRT terminals to interface on-going communications with fellow members of a conference group. Communications are stored in a central computer facility. This system could be described as a dedicated electronic mail system, "dedicated" in the sense that access to the system is private.

The scenario attempts to illustrate the problems of the naive user of a system in which a command language is needed to

SCENARIOS	EQUIPMENT	CENTRAL COMPUTER	MINI-COMPUTER	INTERACTIVE TERMINAL	SLOW SCAN VIDEO TELEPHONE	MICROFICHE & READER	HARD COPY PRINTER	EDITING TYPEWRITER	TAPE RECORDER/PHONE LINK	VOICE GRADE TELEPHONE LINES	AUDIO TELEPHONE
I. Asynchronous Conferencing											
II. Intraorganization Communication											
III. Remote Classroom											
IV. Remote Batch Jobs											
V. Remote Banking											
VI. Word Processing											

FIGURE VI-2. Technological Requirements for Scenarios

access information. The system described is location-independent in the sense that as long as the conferee has access to a CRT and a phone link, he has access to the conference. It is time-independent in the sense that messages can be read from storage or written into storage at any time. However, the system may present access problems that may require support facilities for their solution. Training of users, software support, and support personnel are possible ways to circumvent access problems; an optimal combination of such solutions may have to be determined.

In lieu of training many users to work with terminals or implementing an extensive support system, the second scenario suggests training centralized terminal operators (telecommunications mediators) to retrieve information for members of a larger group and send information from group members to the central computer facility or to similar operators in other divisions. Such a secretarial interface is a viable consideration in the network design.

The third scenario describes the activities of terminal operators at a dispersed center of the fictitious "Lifetime Insurance Company". They update accounts of clients, using buffer storage in the form of tape cartridges, to hold all information generated in the day's work.. At the end of the day, the stored information is transferred via telephone lines to the central computer facility. The job requires little physical movement; prompts furnished by a mini-computer preclude the necessity for

mental involvement. The system is prone to very high error and manpower turnover rates. The task is a typical clerical task. The scenario suggests problem areas which must be kept in mind when the environment for such tasks is designed.

The fourth scenario describes a public telecommunications system. "Remote Public Banking" pictures a person at a pay video telephone negotiating with a bank agent for a loan. The agent's terminal access to a computer data base allows him to quickly determine the applicant's credit rating. A printer inside the phone booth generates the necessary documents.

Whether the applicant would have a better (or worse) chance of being granted a loan if he went to the bank in person, and whether the visual channel is needed at all in this type of transaction are central human factors of interest in the scenario. A side issue generated by this scenario is whether such a system would significantly alter the loan transaction volume. Also the legality of documents generated by remote printers is a matter of concern, since transmission errors may alter the agreed upon negotiations and terms.

The last scenario pictures a system of business document generation based on the ultimate organizational diffusion: a secretarial force working from their homes. Any business organization can access this secretarial force through the contract of their services via a service broker: "Secrepool". Documents to be typed are orally coded on tape by the sender and sent over voice-grade lines to a center which distributes typing jobs to the secretarial force. Upon job request, the center

transfers letters to a secretary's tape recorder , again over voice-grade lines. Secretaries would use editing typewriters to alpha-numerically code messages on magnetic tape. The recorded messages are sent back to the center via telephone. When a sender wishes to read the typed document, he or she would call the center for a copy and would view it via a CRT display. If the document is approved, an electronic signature is entered and the document is electronically sent to central mailing.

Again, the possibility of transmission errors brings to light a concern over the legality of the signed documents. The scenario generates another concern common in systems applying telecommunications technology, i.e, privacy. Safeguards must be built into such a system to ensure letters are viewed only by the appropriate system users.

The proposed system may require a subdivision whose sole responsibility is revision and/or correction of typed documents. Do people become bored doing fulltime error correction? A more general question is what type of work force a fully dispersed system would attract. Is the typical worker amenable to working at home? Would the worker appreciate the direct and indirect costs he would forego by doing so? Would he or she accept a salary decrease if he worked at home?

CHAPTER VI. FOOTNOTES AND REFERENCES

1. Communications Studies Group, Joint Unit for Planning Research, "Electronic Person-to-Person Communications: An Interim Report of a Pilot Study" (London, England: Communications Studies Group, University College, 1970).
2. Communications Studies Group, Joint Unit for Planning Research, "Miscellaneous Papers Submitted to the Steering Committee (London, England: Communications Study Group, University College, 1971).
3. Stahmer, A.E. and Havron, M.D., "Planning Research in Teleconferencing Systems, a report prepared for the Social Policy and Programs Branch, The Department of Communications, Ottawa, Canada (McLean, Virginia: Human Sciences Research, Inc., September, 1973).

VII. TRANSPORTATION AND ENERGY COSTS

Determination of employee commuting distances was integral to the study. With these data, the research team a) had a basis for selection of the dispersed center locations, b) calculated the costs of commuting for the insurance company employees, c) estimated the energy costs associated with commuting and, d) defined the savings in mileage and energy that were possible with a dispersed telecommunications network. This chapter is concerned with the costs - both in dollars and energy - of commuting. All calculations were based on costs of energy and the costs of owning and operating an automobile in January, 1974.

A. BACKGROUND

To calculate the costs of commuting for the insurance company employees, employee residence data by (by ZIP code) were obtained from the insurance company for 2,048 employees (81% of the total number of employees). These data were broken down by employee grade level. Since ZIP codes in the Los Angeles area cover relatively small geographic areas, the centroid of each ZIP code area served as a convenient accumulation point for calculations. The insurance company employees were distributed throughout 212 different ZIP code areas; their distribution is shown in Figure VII-1. Only ZIP codes with five or more employees are shaded.

The travel distance to the central downtown site was

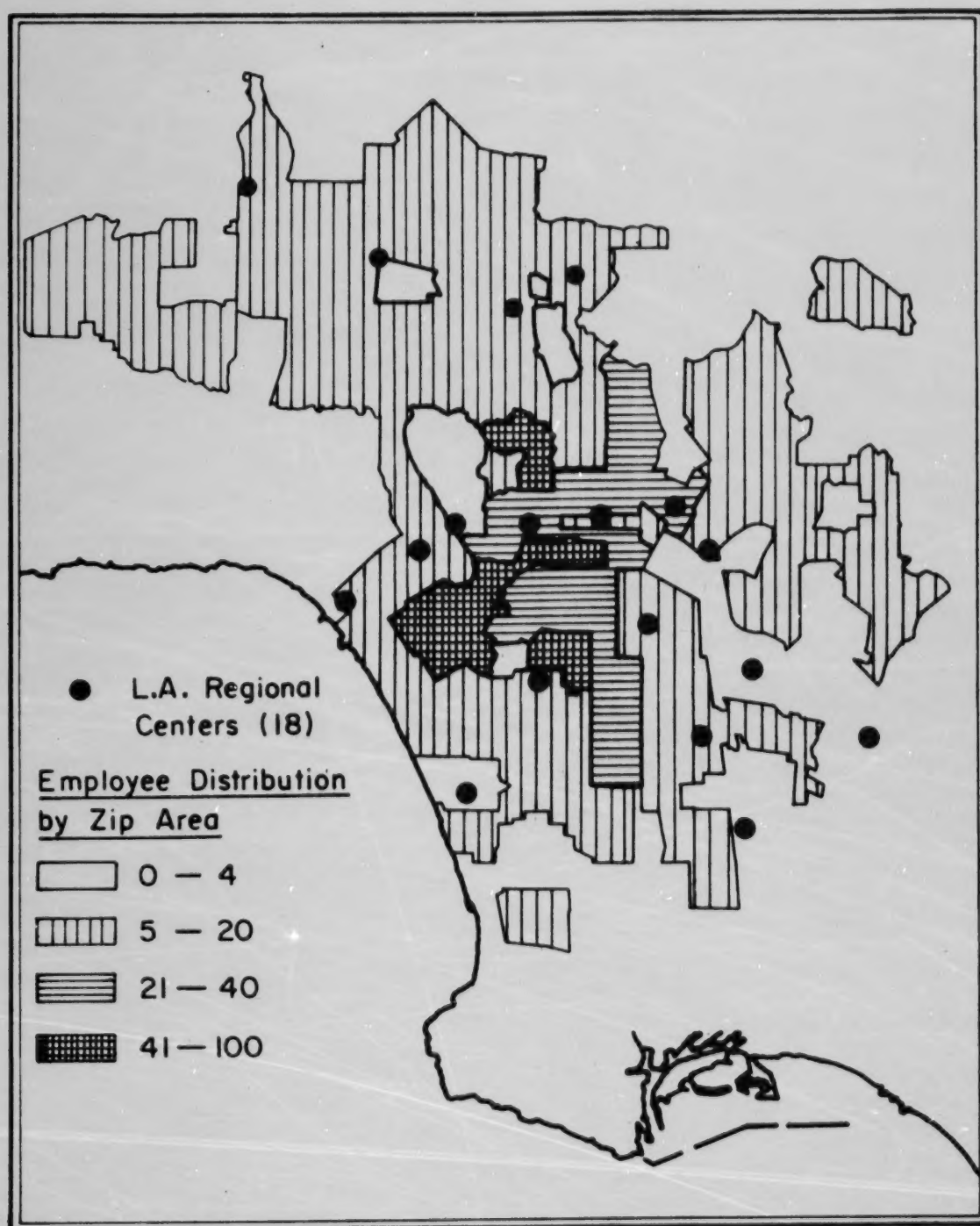


FIGURE VII-1 . Residential distribution of insurance company employees (number of employees residing in each zip code area). Locations of 18 urban centers specified by the Los Angeles City General Plan.

computed for each ZIP code area by assuming that employees would use the Los Angeles freeway system (Figure VII-2) if a freeway was available between the ZIP code area and the headquarters. The results of this analysis, by employee grade level, are shown in Table VII-1 . The one-way weighted average distance, as well as the medians and modes, are given for each category of employee. The average one-way distance for all employees was 10.7 miles, a figure only slightly higher (15%) than the national average one-way commute of 9.4 miles in major metropolitan areas. [VII-1]

B. DOLLAR COSTS

In calculating the costs associated with commuting, it was assumed that the insurance company employees' purchasing habits conform reasonably closely to those of the national average. [VII-2] Information on the costs of automobile ownership and operation were compiled from several sources [VII-3, VII-4, VII-5] and adjusted for inflation and USC study conditions. Table VII-2 shows the results of the cost estimates for the operation of a private automobile, using the average roundtrip distance (21.4) miles) calculated for the IC employees. Two cases are illustrated: the first in which the commuter uses the car solely for commuting and the second in which commuting use, assuming a single car household, covers only 50% of the automobile's total use. In the latter case, only those costs specifically attributable to commuting were used in the estimate. Calculations were done for both compact and subcompact cars and in the composite cost/commuter, a mix of 80% standards and 20%

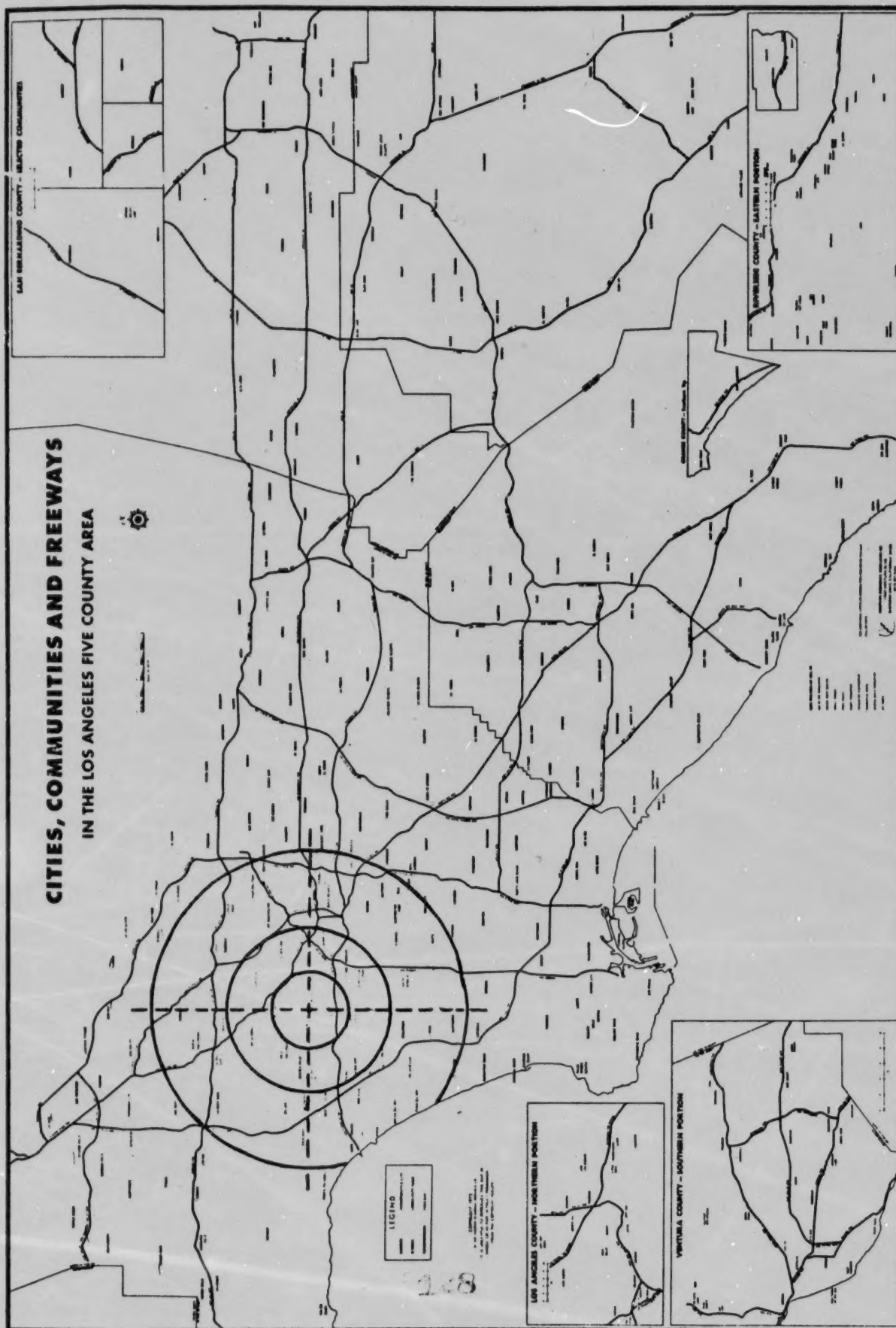


FIGURE VII-2. Los Angeles Freeway System.

<u>CLASS</u>	<u>JOB LEVEL CATEGORIES</u>	<u>PERCENT OF EMPLOYEES</u>	<u>ONE-WAY WEIGHTED AVERAGE DISTANCE IN MILES</u>	<u>MEDIAN</u>	<u>MODE</u>	<u>STANDARD DEVIATION</u>
Executives	20 - 84	6	16.6	17	22	18.9
Middle Management	7 - 12	27	13.3	13	18	16.3
Clerical Workers	1 - 6	67	9.3	8	3	11.8
ALL EMPLOYEES		100	10.7	9	3	13.5

TABLE VII-1. Insurance Company Locational Analysis

COST ELEMENT	AVERAGE ANNUAL COST (\$)			
	Commuter Use Only		50% Commuter Use ^(a)	
	Standard	Subcompact	Standard	Subcompact
Depreciation	643	302	not applicable	
Financing	166	99	not applicable	
Maintenace	315	260	158	130
Gasoline/Oil	260	145	252	138
Insurance	198	183	15(est.)	14(est.)
Parking ^(b)	450	450	450	450
Taxes	75	45	not applicable	
TOTAL COSTS	2,173	1,538	875	732
Total Cost/Commuter ^(c)				
	1,671	1,183	673	563
Composite Cost/Commuter ^(d)				
	1,573		651	

(a) All of the figures shown are costs attributable solely to commuting. Costs which the owner would have to bear even if the use for commuting were discontinued (and ownership were continued) are not included.

(b) Parking costs are not necessarily paid directly by the employee, as are other costs. The figure used is the equivalent cost of off-street parking in typical large metropolitan areas.

(c) At 1.3 persons per automobile.

(d) Assuming 80% standard, 20% subcompact mix.

TABLE VII-2. Private Auto Commuting Direct Operating Costs

subcompacts was assumed. The total and composite costs are both based on a presumed car occupancy of 1.3 persons/vehicle, the national average, [VII-6] although the average occupancy rate per commuter vehicle for Los Angeles is even lower at 1.1 persons per vehicle. [VII-7] Finally, it should be noted that parking costs are included as a direct cost borne by the employee, although in the case of the insurance company under study, the company bears this cost. However, at least 54% of the drivers who commute to work in the Los Angeles central business district pay for their parking on an average weekday [VII-8] and therefore bear the cost directly.

Based on the estimated costs of owning and operating a car to commute the 21.4 miles roundtrip to the insurance company, the total costs of commuting were calculated for the 2,517 insurance company employees. The assumption was made that the insurance company employees had approximately the same distribution of single and multiple car households and households of no automobile ownership as the general population of Los Angeles had at the time of the 1970 census [VII-9]

This ownership distribution was 54.1% (single car ownership), 37.7% (multiple car ownership), and 17.2% (no automobile ownership). Using this distribution, the total annual commuting costs for 2,048 employees for whom we had residence data equaled \$1,816,000. If the same distribution of ownership and use is extrapolated to the 469 employees for whom we did not have residence data, the total annual commuting cost for the insurance company employees equals \$2,232,000.. The average

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commuting cost for the 82.8% of the employees who may be presumed to drive their automobiles to work would equal \$1071 per employee. Expressed in terms of cost per mile for these employees to commute, the cost would be approximately 23 cents per mile. This estimate does not include the 17.2% of the insurance company employee population that does not (as assumed above) own an automobile. It could be assumed that these employees either walk or use forms of transportation (bus, taxi, bicycle) for which no average cost can be determined without exhaustive research.

The preceeding represents, aside from the number of employees used as a basis for calculation, a hypothetical model. In actuality, the assumption of 1.3 persons/passenger vehicle is not the case for the insurance company employees. These employees, like other Los Angelenos, tend to drive alone, averaging 1.1 passengers/vehicle. [VII-9] Elimination of .2 passengers per vehicle in the cost operation calculations roughly compensates for the 17.2% of the employees who were assumed, in the previous calculations, to have used alternate means to arrive at work. Using the total of 2,517 employees, an average of 10.7 miles one-way daily, and a 230 day working year, the total number of miles traveled each year by the insurance company employees would be approximately 12,400,000. On the basis of 1.1 passengers per vehicle and an average cost of 23 cents per passenger mile, the costs of commuting for the 2,517 employees would be approximately \$2,850,000 annually.

C. ENERGY COSTS

One interesting aspect of the potential substitution of telecommunications technology for transportation is the impact on national energy use. In view of the recent emphasis on energy questions at the national level, especially those related to transportation, it is important that this factor in the tradeoff be seriously considered. Although the question of energy use has recently come into widespread national prominence, the historical abundance of various forms of energy has resulted in a fairly general ignorance of the details of energy consumption of various forms of human activity. This apparent abundance of energy has also resulted in the phenomenon that most energy supplies have been underpriced for some time. Consequently, the researcher is faced with two problems in developing accurate comparisons of the relative energy uses of transportation and telecommunications. In the first case, very little information is available as to the detailed energy costs of the production and maintenance of the equipment and systems constituting the subject alternatives. Second, the cost of energy is rapidly rising in some sectors of the economy, less rapidly in others, so that the only definite statement we can make at this time is that these costs are in upward flux. Hence, the following estimates of relative energy consumption and cost of transportation and telecommunications are based on the best data available at this time. For the most part, the estimates are limited to the relative operating energy consumption of transportation and telecommuting in the urban environment. Since energy cost and consumption figures vary

considerably in different publications, the estimates are intended to indicate the relative differences in costs and should not be considered as highly precise evaluations.

1. Relative Energy Consumption

To calculate the energy costs for the insurance company employees, the Btu's per passenger mile, as calculated by Hirst in 1973, [VII-10] were expressed in terms of kilowatt hours. Using the Los Angeles Regional Transportation Study estimate of 1.1 passengers per commuter vehicle mile and using 230 working days a year for 2,517 employees, the total annual energy use by the employees for commuting was approximately 37.4 million kWhs.

Estimates for total energy use of transportation range from 23.8% to 25.2% of gross national energy use. [VII-11, VII-12] This proportion of gross national energy use is expected to remain relatively constant for the next few years. We have assumed a value of 25% for our calculations. This value is translated into Btu's (British thermal units) as 17×10^{15} Btu's in 1971 and 19×10^{15} Btu's in 1975. as the gross national energy consumption for transportation.

Automobile transportation constitutes approximately 50% of all transportation usage according to Hirst.[VII-13] Urban automobile usage accounted for 34.2% of all transportation energy use in 1970. [VII-14] Linear extrapolation of Hirst's data indicates an urban automobile usage of 36.7% in 1975. Using the above estimate for total transportation use, this amounts to 9.2% of total U.S. energy consumption for 1975.

Data we have developed from various sources indicate that commuting accounts for approximately 42% of all urban automobile transportation mileage or 3.9% of total U.S. energy consumption. [VII-15, VII-16] Conversely, commuting can be said to account for 25.4% of U.S. transportation energy consumption. If these percentages of use devoted to commuting were to remain constant, we could say that commuting accounted for the expenditure of 2.6×10^{15} Btu's in 1971 and, if unaltered, will account for 2.9×10^{15} Btu's in 1975. Consequently, each percent reduction in urban commuting would result in a total U.S. energy conservation increase of about 30 trillion Btu's annually. We can convert this figure to equivalent kilowatt hour by noting that there are 3413 Btu's per kilowatt hours. Consequently, a 1% reduction in urban commuting would result in a reduction in total U.S. energy consumption of approximately 8.6 billion kilowatt hours annually.

The insurance company employees' daily commute average of 21.4 miles round trip was used as the basis for estimating the energy consumption of an individual commuter. Although slightly higher than the national average round trip commute of 18.8 miles, the insurance company average was considered to be representative of the daily commute for white collar workers in a major metropolitan area. If we further assume, on the basis of the Los Angeles experience, that the average loading of a private automobile used for urban commuting is 1.1 passengers, we find, at 11,340 Btu's per vehicle mile [VII-17] that the average urban commuter consumes 64.64 kilowatt hours per day. Using Hirst's

data for energy consumption for mass transit systems, we find equivalent energy consumptions of 24.1 kilowatt hours per day for each commuter for normally loaded mass transit (a load factor of 30%). A fully loaded mass transit system, i.e., one in which all available spaces were always occupied by commuters, would use 4.8 kilowatt hours per day per commuter.

We arrive at comparable costs for telecommuting by noting that a typical computer terminal uses from 100 to 125 watts continuously when it is in operation. A 3 kHz bandwidth phone line uses less than 1 watt after the connection is established (there is an initial 10-15 watt power consumption in a switched network used for the ringing circuits) in a typical urban area. The marginal costs of computer operation per terminal are estimated at approximately 10 watts. If we postulate a terminal use and/or connect time of 5 hours per day per telecommuter, a figure which is considerably higher than present experience with the insurance company, we arrive at a total energy consumption of 0.68 kilowatt hours per day for each telecommuter. However, since this figure is the delivered electrical energy to the telecommuter, we must put in an additional conversion factor to refer the energy cost back to input fuel energy required at the central electrical power plant which provides the primary energy for telecommuting. Thus we end up with a value of 2.2 kilowatt hours per day for each telecommuter as the gross basic energy requirement. This estimate is quite conservative since our survey of insurance company employees indicates that each could take care of his or her data transmission needs with about 10 minutes

of terminal time. We inflated this time to include new uses of the terminal, e.g., development of "paperless" office systems, electronic mail, remote job training and remote supervision.

From these estimates, we find that the relative energy consumption advantage of telecommuting over commuting (i.e., the ratio of commuting energy consumption to telecommuting energy consumption) is 29 when the private automobile is used, 11 when normally loaded mass transit is used, and 2 for 100% utilized mass transit systems (Figure VII-3). However, since most urban passenger traffic (approximately 97% uses the automobile, we find that the net savings in energy consumption produced by telecommuting is 96% of the fraction of commuting replaced. Consequently, the replacement of urban commuting by a telecommuting (at least telecommuting which is carried out at telephone bandwidths) would result in a net reduction of U.S. energy consumption of 8.2 billion kilowatt hours annually for each percent of the urban commuting work force which engages in the substitution.

Since most transportation energy related to commuting is derived from the use of petroleum, we can translate these results to annual savings in terms of barrels of gasoline. At 125,000 Btu's per gallon of gasoline and 42 gallons per barrel, we have an energy value of 1,539 kilowatt hours per barrel of gasoline [VII-18]. Consequently, a 1% replacement of urban commuting by telecommuting would result in a net reduction of U.S. gasoline consumption of 5.36 million barrels annually. [VII-19] A recent article in Business Week [VII-20] indicates that total U.S.

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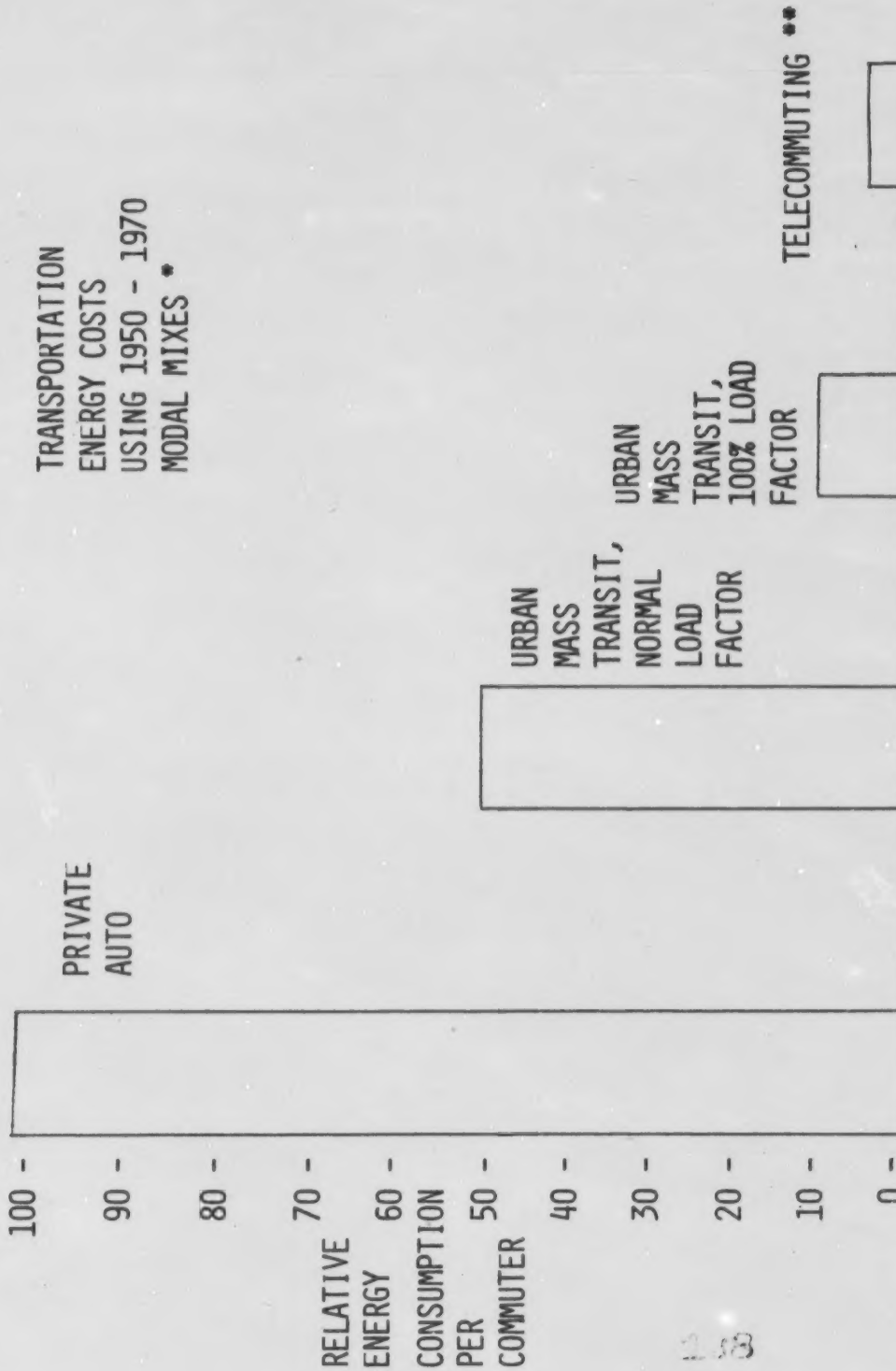


FIGURE VII-3. RELATIVE ENERGY CONSUMPTION OF INTRAURBAN COMMUTING.

* FROM HIRST, E., "ENERGY INTENSIVENESS OF PASSENGER AND FREIGHT TRANSPORTATION MODES."

** INCLUDES ELECTRICAL POWER PLANT ENERGY LOSSES.

gasoline imports in May, 1975, were 200,000 barrels per day or 73,000,000 barrels per year (although federal government estimates for 1974 averaged 82,500 barrels/day or 30,000,000 barrels per year). [VII-21] Thus replacement of 13.6%, (or 5.6% depending on which gasoline import figures are used) of urban commuting by telecommuting could eliminate the U.S. requirement for imported gasoline, assuming, of course, that all such imports would ordinarily be used for automobile consumption rather than other purposes.

2. Relative Energy Prices

Although the fairly high energy consumption advantage of telecommuting over commuting may exert a moral persuasion for potential users of telecommuting, it is important to recognize that cost savings in dollar terms is likely to be even more persuasive than external inducements such as rationing.

Using Hirst's more conservative values for the energy content of gasoline (136,000 Btu's per gallon as opposed to the federal figures of 125,000 Btu's per gallon), [VII-22, VII-23] we find that the cost per kilowatt hour for gasoline is $0.0251 \times$ the price per gallon. That is, for gasoline at 55 cents per gallon, the energy price is 1.38 cents per kilowatt hour. This current price for gasoline energy can be compared with a national average of 1.60 cents per kilowatt hour for delivered electrical energy in 1971, the latest year for which we have available data [VII-24] Since the ratio between energy consumption for commuting and delivered electrical energy for telecommuting is 95.1, we

find that the differing prices of the two forms of energy result in an energy cost ratio of 82 to 1. Thus, even though the rate per kilowatt hour is higher for electrical energy than for energy provided by gasoline, the energy price ratio between commuting and telecommuting is higher than the energy consumption ratio since our energy consumption figures are based on total fuel energy used in the process, while the cost figures are based on the delivered energy prices.

As gasoline prices increase, the cost advantage of telecommuting can be expected to continue to increase since the fuel costs constitute almost the entirety of the commuting energy cost while the fuel cost is only a fraction of the telecommuting energy cost (power plant operation, capital equipment amortization, etc., constitute a larger proportion of the costs).

It should be noted, however, that because energy costs constitute a fairly small proportion of the total direct costs of commuting or telecommuting to the individual business firm, they cannot be expected to exert a profound economic influence on the decision by a firm to disperse through the use of telecommunications. Rationing or other restriction of the gasoline supply, for example, is much more likely to sway this decision. Executives from several companies interviewed during the course of our research divulged preliminary plans to develop rudimentary telecommuting systems, at least for some of their fellow executives. These plans are made primarily because of the threat of unavailability of gasoline supplies for individuals located at long distances from the central office, rather than

because of the cost of these supplies to either the firms or the individuals. However, the energy cost ratios may provide a persuasive argument for developing a new view of government policies in fuel allocation, distribution and price control.

3. 35 Center Configuration

The savings in energy and transportation costs can be dramatically illustrated by considering the decrease in roundtrip mileage produced by the presence of 35 centers throughout the city. As shown in Figure VII-4, the average one-way mileage per employee would decrease from 10.7 miles to 3.1 miles, with comparable reductions in energy and transportation costs. The energy and cost savings are shown in Figure VII-5.

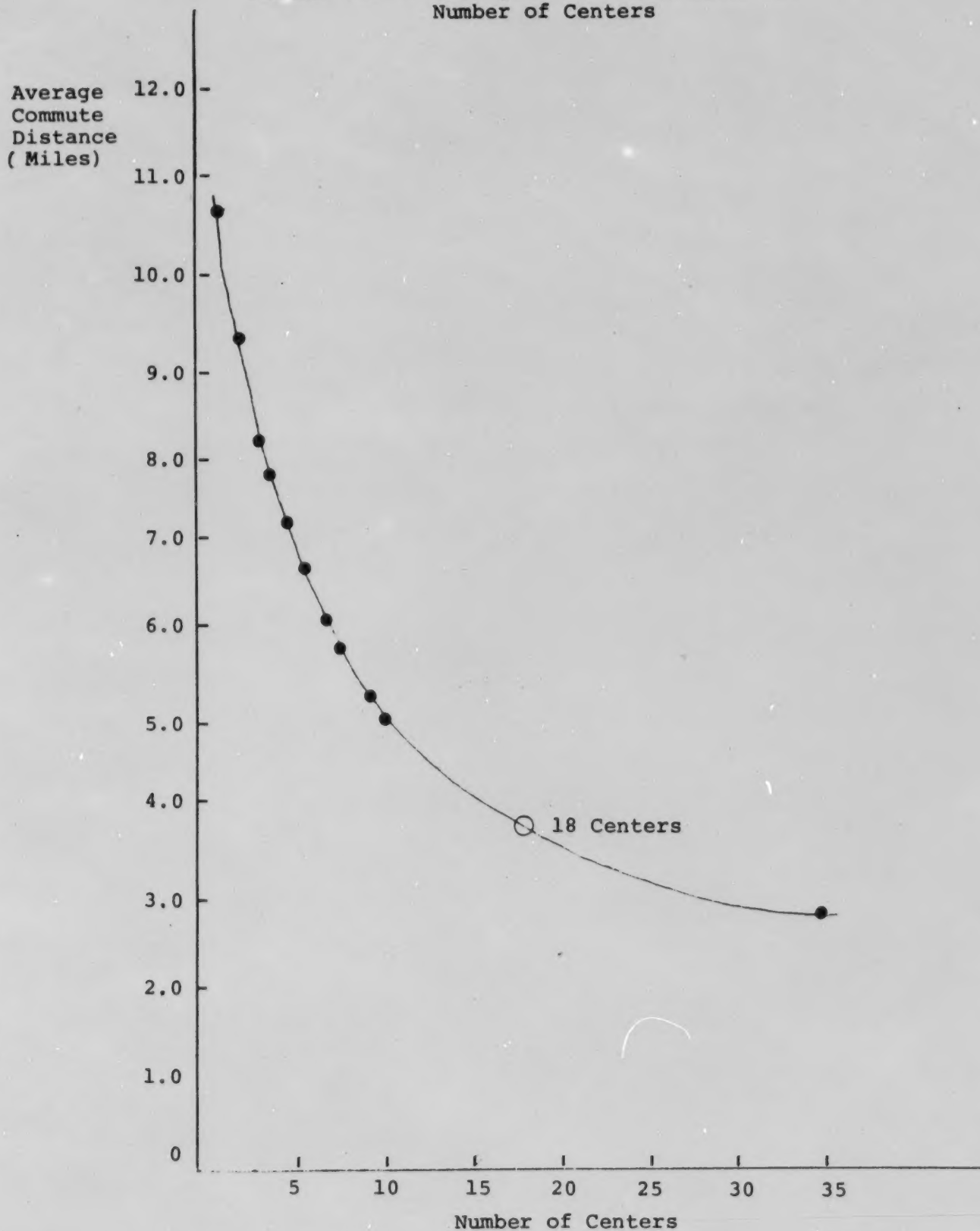
4. 18 Center Configuration

Figure VII-4 illustrates that, after addition of the 18th center, the decrease in energy cost and transportation mileage is very gradual. Conversely, however, the costs in establishing 35 centers and maintaining the necessary telecommunications equipment at each of them would begin to outweigh the savings in transportation and energy costs.

With 18 centers, the average one-way distance per employee would be 3.9 miles, with an approximate annual savings in transportation energy of 23.8 million kilowatt hours. This is slightly offset by telecommuting energy costs shown in Figure VII-6 as a function of the number of employees per terminal.

At this point, several observations should be made. One, Figures VII-5 and VII-6 indicate a leveling of the curve at

FIGURE VII-4. Average Commute Distance vs.
Number of Centers



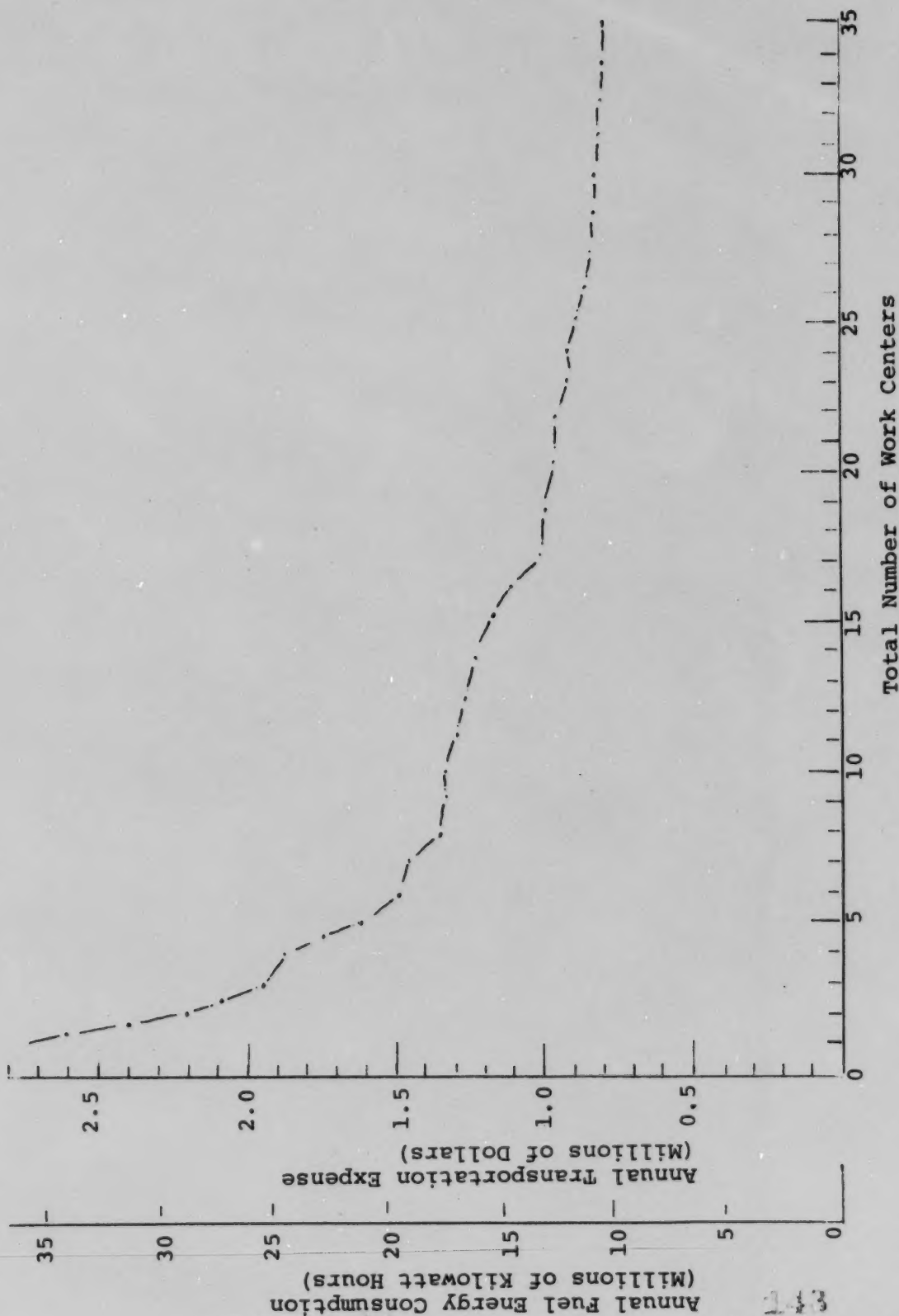


FIGURE VII-5. Estimated Annual Commuting Costs (IC)¹

ASSUMPTIONS

- IC Population: 2,517
- Terminal + Peripherals + Communications Line Consumption: 160 Watts.
- 8 Hour Use Time/Day/Terminal
- Basic Fuel Energy = $3.3 \times$ Delivered Electrical Energy
- 230 Day Work Year. Terminals Off during Non-Working Hours

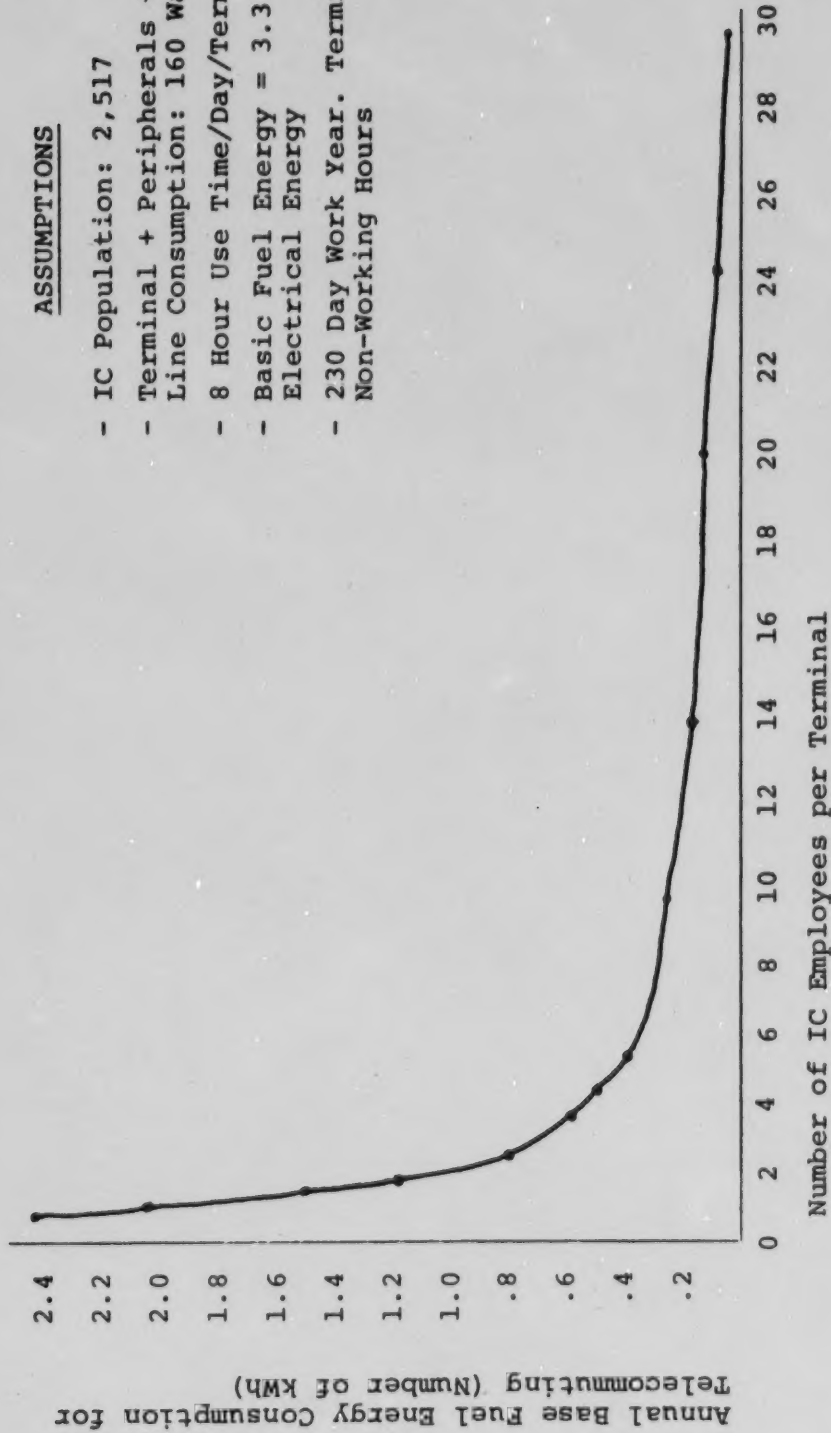


FIGURE VII-6. Telecommuting Energy Costs (IC)

between six and seven centers, rather than at 18 centers, as is the case for the commuting distances plotted in Figure VII-4. One would expect this kind of relationship to hold for many companies, namely, that they can obtain considerable cost savings through establishing a relatively small number of centers. Second, it should be noted that the above calculations represent conservative estimates of the savings. Third, it is difficult to determine, or even guess at the reactions of the employee to the reduced mileage. If the employee owns more than one car, the reduction in distance to work might encourage him to divest himself of one of those cars. For employees who own only one car, considerable savings could be realized in terms of automobile operation costs. If both sets of car owners converted to bicycling or walking the shortened distance to work, the savings would be even greater, not to mention the increase in physical health of the employees.

CHAPTER VII. FOOTNOTES AND REFERENCES

1. Automobile Manufacturers Association, Inc., 1971 Automobile Facts and Figures (Detroit, Michigan: Automobile Manufacturers Association, Inc., 1971), p.52

2. Liston, L.L. and Gauthier, C.L., Costs of Operating an Automobile (Washington, D.C.: U.S. Department of Transportation, Federal Highway Administration, Office of Highway Planning, Highway Statistics Division, April, 1972), pp. 3-5.

3. Ibid, pp. 3-5.

4. U.S. Bureau of the Census, Statistical Abstract of the United States (Washington, D.C.: U.S. Government Printing Office, 1972), p. 548.

5. Automobile Manufacturers Association, Inc., op.cit., p.46-48.

6. Ibid, p.52.

7. Los Angeles Regional Transportation Study, Base Year Report: 1971 Origin-Destination Survey (Los Angeles, California: Los Angeles Regional Transportation Study, December, 1971), p.70.

8. Ibid, p.72.

9. Automobile Manufacturers Association, Inc., op.cit., p.46.

10. Hirst, Eric, Energy Intensiveness of Passenger and Freight Transport Modes, 1950-1970, (Oak Ridge, Tennessee: Oak Ridge National Laboratory, April, 1973), p.27. Report # ORNL-NSF-EP-44.

11. Hirst, E., op.cit., p.4.

12. Stanford Research Institute, Patterns of Energy Consumption in the United States (Washington, D.C.: U.S. Government Printing Office, 1972).

13. Hirst, E., op.cit., p.4.

14. Ibid, p.24.

15. Automobile Manufacturers Association, Inc., op.cit., p.52.
16. Harkness, R.C., Communications Substitutes for Urban Travel, Transportation Engineering Journal, Proceedings of the ASCE Vol. TE3, 1973, pp. 585-595.
17. Hirst, E., op.cit., p.6.
18. Ibid, p.14.
19. Congressional Record Service, Energy Facts(Washington, D.C.: Library of Congress, 1973), p.493.
20. Ibid, p. 493.
21. Business Week, June 1, 1974, p.26.
22. U.S. Senate, Committee on Interior and Insular Affairs, Current Analysis of Petroleum Supplies for First Quarter 1974(Washington, D.C.: U.S. Government Printing Office, 1974), p.53.
23. Congressional Record Service, opp.cit., p. 328-329.
24. Hirst, Eric, Energy Consumption for Transportation in the U.S. (Oak Ridge, Tennessee: Oak Ridge National Laboratory, March, 1972), p.5. Report # ORNL,NSF-EP-15.
25. U.S. Department of Commerce, op.cit., p.512.

CHAPTER VIII. COST-BENEFIT ANALYSIS

A. INTRODUCTION

The basic structure and communication patterns of some of the major organizational components of the insurance company which served as the subject of our case study were outlined in Chapter IV. The conclusions of that chapter were that the insurance company operations were quite suitable for decentralization through the use of telecommunications and computer technology. Because of a set of external constraints and forces, such as the decreasing availability of an appropriate labor force in the central business district and a high clerical personnel turnover rate, the insurance company had independently decided to move its operations from the central business district to one or more geographical areas which would allow amelioration of these problems. However, certain constraints imposed by the national headquarters of the company upon a decentralization move act to modify the way in which the insurance company decentralizes. Specifically, the insurance company is currently fragmenting, as per the description in Chapter III, rather than dispersing. The following sections summarize a cost-benefit analysis for this particular company for two cases: the move actually planned by the company and the moves which makes greater use of telecommunications technology and seems to have even greater economic attractiveness.

B. CORPORATE DECENTRALIZATION POLICIES

In Chapter V, a list of potential sites for dispersion of the insurance company was developed under the assumption that the primary goal of the dispersion was to reduce the employee commuting distance to the point of diminishing returns. Under this assumption, a set of 18 potential centers for the dispersed operations of the company was selected. An implicit assumption in that analysis was that future employee residential distributions would be similar to the present case. However, a set of additional constraints are imposed by corporate policy of the insurance company in its selection of actual sites.

The following four criteria have been established by the insurance company to evaluate proposed sites for the establishment of the satellites. These criteria represent minimum requirements; the responsible executives at the regional home office of the insurance company believe that all four of these must be met if the proposed satellite location is to be confirmed.

(1) An ample labor market should exist in the environs of the site, consisting of well qualified people who are presently and will continue to be available in the foreseeable future. This labor market includes not only recent high school graduates, but also housewives who heretofore have been unable to commute to the central business district for employment. This segment of the labor market affords the company the opportunity to establish part time and/or flexible working hours and obtain workers who were not previously available.

(2) Suitable locations should be at least 15 but not more than 30 miles from the current centralized location.

(3) Both temporary quarters and land for permanent buildings must be available at a reasonable cost. The insurance

company has adopted a policy of purchasing land for its office locations and constructing a suitable office building on the site selected. Once the site has been selected and purchased, temporary office space will be rented while a building is constructed. This will allow the insurance company to hire employees from the area and assimilate them into the organization while construction is underway.

(4) The satellite location must be able to meet equal opportunity employment requirements without incurring significant added expense or unduly distorting the company's normal employment practices. To meet this criterion, it should be possible (from the standpoints both of transportation and housing availability) for members of the existing staff to transfer to the new locations. In addition, there should be access to minority populations for new hires.

Since the insurance company plans to complete its decentralization in three years, and since the primary labor pool for clerical work has been high school graduates, the current enrollment of junior high schools in the Los Angeles metropolitan area constitutes the labor market of primary interest. This consideration, the minimum satellite size constraint imposed by the national headquarters (1000 employees), and the four criteria just listed bias the potential satellite locations toward a concentration in the geographical area of Los Angeles known as the San Fernando Valley. A list of the 15 most desirable sites resulting from the analysis is given in Table VIII-1. These sites were then used as the basis for developing another set of transportation cost analyses similar to those of Chapter VII.

C. PRIMARY DECENTRALIZATION COST ELEMENTS

Clearly, the costs of transportation are not the only considerations to be made by a firm when it is deciding whether or not to decentralize. In fact, since the employee commuting

SITE NUMBER	ZIP CODE	COMMUNITY
1	90290	Topanga
2	91364	Woodland Hills
3	91342	San Fernando
4	91350	Saugus
5	91304	Canoga Park
6	91324	Northridge
7	91344	San Fernando
8	91306	Canoga Park
9	91311	Chatsworth
10	91340	San Fernando
11	91302	Calabasas
12	91301	Agoura
13	91321	Newhall
14	91355	Valencia
15	91303	Canoga Park

TABLE VIII-1. Desirable Sites- San Fernando Valley

costs are only indirectly related to the cost to the company, the other costs of operation are likely to play a much greater part in the decision to decentralize. Furthermore, in the case of the insurance company, and for many companies now in the process of decentralizing from urban areas, but retaining the old philosophies of corporate organization, there is an additional decentralization cost: that of personnel relocation for key employees, or for all employees who wish to move, depending on the details of corporate policy. Some of these costs are as follows. Those categories marked with asterisks are cost elements which would not be borne or would be decreased by a company undergoing dispersed decentralization.

1. New Corporate Offices*

When it decentralizes, the insurance company will establish a new headquarters office for their high level executive staff in the central business district. The old headquarters building would be renovated and leased. The lease income from the old headquarters would offset some of the costs of establishing a new headquarters office and other decentralization costs. Of course, in the long term, there is the consideration as to whether the available lease income would continue to increase in the DCBD if decentralization becomes a popular phenomenon. However, since urban populations tend to show a steady increase, it is anticipated that CBD occupancy will remain at a relatively high level, with the remainder of the business population increase being absorbed by growth of the regional business centers.

2. Personnel Relocation Expense*

This cost represents the moving expenses and transfer allowances paid to employees and/or severance pay for personnel who are unwilling to locate and for whom local placement within the insurance company cannot be found. For the company studied, which is undergoing, in large part, a "traditional" decentralization, it is estimated that there will be 1,250 people involved in a reimbursed relocation to several fragmented centers for a total cost to the company of \$791,000.

3. Training Cost*

This expense represents the training of new clerks hired to replace clerical employees not accepting relocation (143 in the case studied), or the retraining of employees learning new jobs as a consequence of dispersion, the loss of productivity, and the time of those performing the training.

4. Rental Expense*

This expense results from the additional cost of housing the satellite operations for two years until they can be moved into their permanent, company-owned quarters. For the company studied, this rental expense of \$250,000 is offset by rentals received from leasing the present headquarters site. A better strategy (if it were not for corporate policy) might be to lease all decentralized office space and not incur the expense of a corporate owned and occupied set of buildings.

5. Moving Expense

This category includes the cost of moving all furniture, files and equipment from the current central business district location to the various satellite offices.

6. Computer Moving Expense*

This represents the cost of moving the central computer to a new site in the central business district. Of course, this would not always be a cost incurred by a company moving if it decided to retain at least a portion of the space in the building it originally occupied. But here too, this represents an expense incurred as a consequence of other corporate policies in which these economic considerations play a less significant part.

7. Centralized Communications Expense

This represents the cost of communication equipment at the computer site to allow a computer to operate on a time-sharing basis with remotely located satellites. The insurance company anticipates converting all its employees to operation in a time-sharing computer mode, whether or not it decentralizes. Therefore, the cost of computer terminals are not included in the subsequent cost-benefit calculations, since the company will incur these costs anyway.

8. Planning and Contingency Expenses*

This cost represents the salaries of the planning staff required to coordinate the move and includes a contingency reserve.

9. Renovation and Leasing Costs*

These costs include expenses incurred in renovating the current headquarters site in the CBD and the expenses required to lease the building to new occupants.

D. COST-BENEFIT ANALYSIS

With these preliminary comments, we now present a preliminary cost-benefit analysis of the two primary alternatives:

- I. Satellite offices located in the San Fernando Valley - a fragmented decentralization;
- II. Satellite offices located uniformly throughout Los Angeles - a dispersed decentralization.

In the analysis that follows, all costs and benefits are compared as increments (or decrements) to the alternative of remaining in the present centralized location.

1. Summary of Alternatives

Alternative I establishes a series of office satellites in the San Fernando Valley. IC has a corporate policy of owning the land and the buildings of its office operations. This means that IC will lease temporary office space to house the employees until a permanent facility can be constructed and occupied. Thus, temporary office space must be rented while construction is in progress. The headquarters for the executives of the IC will be established in a central business district location. The present building will be renovated and leased. Employee separation and moving expenses must be paid, as well as the costs to establish the satellite offices. However, employee commuting costs should be less than at present, judging from the company's experience with its present satellite offices. The assumption is made that IC's experience with its current satellite offices continues to be valid. Thus, it is expected that, once decentralization is undertaken, turnover and training costs will be less and

productivity will be higher.

Alternative II establishes office satellites dispersed throughout the Los Angeles region. By considering a larger geographical region, employee separation and moving expenses will be reduced in comparison to Alternative I (and would be eliminated, were it not for some additional factors). The same types of benefits occur in Alternative II as in Alternative I; however, the magnitudes of the benefits are different.

2. Assumptions

Alternative I - Fragmentation

- a) Office satellites will be established in the San Fernando Valley only.
- b) A new headquarters for the executives of IC will be established in a central business district location. The present building will be renovated and leased.
- c) IC has a corporate policy of owning land rather than leasing. The land and building investments are assumed to have a life of 25 years.
- d) The one-time expenses will be written off over a ten year period.
- e) Temporary buildings will be leased for a period of time until permanent facilities can be constructed.
- f) A 15% productivity improvement will occur in the San Fernando Valley satellites over present centralized headquarters operations. This estimate is based on IC's present experience with such office satellites.
- g) The average compensation per employee for all levels is \$7,500 per year.
- h) The average yearly compensation for clerical employees is \$6,500.
- i) There are currently 2,500 employees, of whom approximately 1,700 are clerical.

j) Clerical employee turnover during the first year of service will be 45% for the office satellites as compared to 73% for the present centralized office, based on IC's experience with its current satellites.

k) Approximately 27% of the executives will be assigned to a central headquarters office. The remaining executives will be assigned to the San Fernando Valley.

l) Personnel relocation expenses as described in Section C will be paid.

Alternative II - Dispersion

a) Office satellites will be established in the Los Angeles region.

b) A new headquarters for the executives of IC will be established in a central business district location. The present building will be renovated and leased.

c) Office space will be leased in the sites selected for office satellites. Current office rental rates in these areas were used to determine yearly office space cost.

d) IC requires a rate of return of 10% on all investments.

e) The one time expenses associated with the decentralization will be written off over a ten year period.

f) A 12% productivity improvement will occur over present centralized headquarters operation. This estimate is based on IC's experience with such office satellites and is somewhat lower than that of Alternative I to represent a decreased level of quality in the potential labor pool.

g) The average compensation per employee for all levels is \$7500 per year.

h) The average yearly compensation for clerical employees is \$6,500.

i) There are currently 2500 employees, of which approximately 1700 are clerical.

j) Clerical employee turnover during the first year of service will be 45% for the office satellites as compared to 73% for the present centralized office. This estimate is based on IC's experience with its current satellites.

3. Costs - IC

A number of costs that must be incurred, regardless of the number of office satellites established, are associated with decentralization. These costs apply to both the alternatives. An additional training cost must be incurred in the establishment of satellite offices. Since decentralization in the greater Los Angeles area will require fewer new employees to be trained than a move to the San Fernando Valley would require, the cost is \$25,000 rather than \$87,000. The cost of training a new employee is estimated to be approximately \$600 per person in either case. The additional communication cost required for both alternatives is the same and consists of teleprocessing equipment for the computer. The rental fixed cost is \$250,000 for Alternative I since an office must be leased for a period of time until construction is completed on the office satellites. This cost does not occur for Alternative II, since IC would move directly into the leased office space. IC will have moving expenses of \$250,000 for either alternative in moving office equipment to the satellite locations. The personnel moving and separation cost is \$791,000 for Alternative I, since many people who presently are employed by IC do not live directly in the San Fernando Valley. This cost is \$50,000 for Alternative II since the Los Angeles region is a much larger geographical area and hence, most present office employees can be reassigned to new satellite offices. There will be a certain amount of frictional placement and, as a result, this amount represents the cost of being unable to place every current employee in a suitable position, i.e., one of the

costs of residual fragmentation. If a completely dispersed operation were considered feasible, this cost would not be incurred. The cost of moving the computers and the supporting peripheral equipment is \$100,000 in both cases. There will also be a category of funds required for the salaries of the planning staff to coordinate the decentralization, plus a contingency reserve. Because the decentralization to the San Fernando Valley will cause more employee separation and moving expenses to be incurred than Alternative II, this planning and contingency cost category is \$350,000 for Alternative I and \$150,000 for Alternative II. Table VIII-2 shows a detailed listing of these fixed costs and also shows the annualized cost based on a ten year amortization at a 10% internal rate of return.

In addition to the one-time fixed costs, there are a number of fixed costs that will occur each year, independent of the number of satellites. These include the costs of the teleprocessing equipment at the central computer (\$20,000), duplication of some administrative tasks (\$50,000), and additional travel for executives (\$25,000). These costs were estimated by executives of the insurance company.

An important consideration is the fact that if IC decentralizes, it will lose its principal office tax deduction. Under a provision of the California State Constitution, an insurance company is entitled to reduce its premium taxes by an amount equal to the property tax on its principal office maintained in the state. Only one office is eligible for this benefit. To the extent that the property tax on the present

FIXED COSTS:	ALTERNATIVES	
	I San Fernando Valley	II Los Angeles Region
Additional Training	\$ 87,000	25,000
Additional Communication	122,000	122,000
Rent	250,000	0
Moving Expenses	250,000	250,000
Personnel Moving/Separation	791,000	50,000
Computer Moving	100,000	100,000
Miscellaneous	350,000	150,000
Renovation & Leasing Expenses	750,000	750,000
	<u>\$2,700,000</u>	<u>\$1,447,000</u>
Annualized Fixed Cost (10% internal rate of return)	\$ 439,425	\$ 235,500

TABLE VIII-2. One-Time Fixed Costs of Decentralization

headquarters building is greater than that on the satellite with the greatest tax against it, there would be a net overall loss. The amount of this loss is estimated at \$350,000.

4. Benefits - IC

There are five principal benefits that will occur if IC decentralizes using either Alternative I or Alternative II:

- a) reduction in staff;
- b) reduced employee turnover and training;
- c) reduced salaries for clerical employees;
- d) elimination of the lunch program;
- e) income from lease of headquarters site.

Based on IC's past experience with its present satellite operations, it can reasonably be expected that, due to a higher caliber of applicants, a more motivated work force, and a better working environment, the productivity at the satellite offices will be higher than in the present centralized office. IC's executives believe that a 15% reduction in clerical personnel will be attainable in the San Fernando Valley decentralization (Alternative I) and a 12% reduction will occur if IC decentralizes throughout the Los Angeles region. This will allow IC to perform the same amount of work using fewer people, and thus lower the total operating cost. Since this benefit will occur primarily at the clerical worker level, the calculations are based upon an average yearly clerical salary of \$6,500. It can be assumed that although the number of middle management employees required to supervise the clerical force would also be reduced, this reduction is offset by the slight supervisory duplication resulting from multiple work sites.

IC estimates the cost of hiring and training a new employee is \$600. The company currently experiences a turnover rate of 73% for first year employees at its central headquarters and of 45% at its existing satellites. It is assumed that this 28% reduction in turnover will continue to hold. These calculations involve only the clerical employees since the only significant hiring is done at that level.

Reduced salaries (or, more realistically, reduced rates of salary increase) for clerical employees and abolition of the present free lunch program are two more benefits IC anticipates. IC believes it can continue to maintain a \$10/week/employee pay differential between the present headquarters and the satellite offices. This wage differential has been paid to attract employees to work in the central business district location. With a decentralized satellite office configuration, employees can be hired locally and the insurance company does not need to provide this incentive. The present cost of lunches for the employees at the CBD location is \$8/week/employee. The following calculations are based on the anticipated workforce at the satellite offices, which should be 85% of the current work force for Alternative I and 88% for Alternative II. The wage differential is assumed only for the clerical employees and not for the middle or top management employees. Thus, the calculations are based on the 1700 clerical employees, for whom two week vacations are assumed.

The net annual income expected from the lease rental of the present office building is expected to be approximately \$1,800,00 per year.

Table VIII-3 presents a summary of the costs and benefits for IC, exclusive of the costs of establishing the satellites. An analysis of the costs and benefits shows that the magnitude of the benefits expected to accrue to IC is large enough to warrant considering decentralization.

5. Employee Benefits

The cost-benefit analysis for employees considers only the clerical employees, since middle management personnel and executives will not be affected by the lower starting salaries. As far as employees are concerned, the two alternatives (the San Fernando Valley and the general Los Angeles region) are ultimately equivalent because both permit working closer to where they live in the long term.

IC's benefits of reduced clerical salaries and elimination of free lunches are costs to the individual employees. The average clerical employee now making \$6500 per year, single and with no other sources of income, would have state and federal income taxes reduced by \$134 (1974 Tax Schedule) if pay is reduced to \$5,980. Thus, the net annual cost of the salary reduction to the employee is \$386. The lunch cost of \$400 per year is an out-of-pocket expense to employees. The total cost is \$786 per year.

6. Employee Benefits

The costs to the employees from the decentralization are, in most cases, offset by reduced transportation costs and savings in time. The minimum distance that must be saved by a clerical

	I San Fernando Valley	II Los Angeles Region
ANNUAL COSTS:		
Fixed costs of Decentrali- zation (Table VIII-2)	439,000	236,000
Teleprocessing Equipment for Computer	20,000	20,000
Administrative Duplication	50,000	50,000
Additional Travel	25,000	25,000
Loss of Tax Deduction	350,000	350,000
	<u>\$ 884,000</u>	<u>\$ 681,000</u>
ANNUAL BENEFITS:		
Staff Reduction	\$1,658,000	1,326,000
Turnover & Training	354,000	341,000
Reduced Salaries	751,000	778,000
Lunch Reduction	578,000	598,000
Income from Lease of Headquarters Site	<u>1,785,000</u>	<u>1,785,000</u>
	\$5,126,000	\$4,828,000
Benefits-Costs =	\$4,242,000	\$4,147,000

TABLE VIII-3. Summary of Costs & Benefits - IC
(Preliminary)*

* All values rounded to nearest 1,000.

employee if the benefits of relocation are to exceed the cost can be determined from the following breakeven calculation for a typical employee:

Annual Dollar Costs (\$786) = Annual Dollar Savings

\$786 = Transportation Saving plus Travel Time Saving

\$786 = (Mileage Saving (x)/Trip) (2 Trips/Day) (Number Working Days/Year) (Cost/Mile) plus (Cost of Travel/Hour) (Number Hours/Mile) (Mileage Saving/Trip) (2 Trips/Day) (Number Working Days/Year).

\$786 = (x) (2) (230) (.23) plus [(\$2.89) (1/32)]

Therefore, x = 7.08 miles. Thus, a typical employee saving more than seven miles per trip (approximately 60% of the present clerical staff) will have a net benefit value. An employee saving less than that will have a net cost, provided the employee continues to use the private automobile for transportation.

IX. EFFECTIVENESS, PERCEPTIONS AND ATTITUDES

1. INTRODUCTION

Effectiveness and perceived effectiveness are important elements in the telecommunications-transportation substitution. As noted in Chapter II, prior research has most frequently dealt with these issues in regard to teleconferencing on the management level. Many of the studies performed to date have concluded that a large number of management functions can be performed effectively using telephone bandwidth communications, provided that certain additional criteria are satisfied. Two of the most important criteria are:

a) The participants in the communication process must "know" each other, i.e., be familiar with contextual clues as to each other's attitudes, emotions, etc., with the implication that face-to-face meetings must be held to some extent and occasionally repeated, as a prerequisite to effective teleconferencing.

b) Some form of contextual or graphic display must be provided. Arguments vary considerably as to the best form and/or extent of these displays. The advantages provided by standard TV capabilities do not appear to be sufficient in most cases to warrant the additional costs of the capabilities, at least for short, relatively local conferences involving a small number of people. [IX-1]

Reid et.al. have also performed extensive studies on management perceptions of the effectiveness of telecommunications as a substitute for travel. Reid found that management level personnel felt more confident about their decision-making abilities in face-to-face settings as opposed to a teleconferencing mode, even though there were no substantial

differences in judgments made in the latter mode.

Since the USC study emphasized applications of telecommunications at the clerical level, the research team was concerned with both the effectiveness of telecommunications use at this level and the perceptions of potential users of a telecommunications system. Unfortunately, few data on these two elements are available in the public domain, and the conditions of the USC study precluded measurements of effectiveness or an extensive examination of the attitudes of the clerical staff at the insurance company.

In lieu of working specifically with the IC population to assess effectiveness and attitudes, the research team designed a series of surveys to assess user attitudes toward telecommunications before and after experience with an existing system. Also, a general survey was taken of a random sample of the Los Angeles general adult population to gather data on public knowledge of and attitudes toward the various types and potential uses of telecommunications. A similar set of surveys were conducted with USC evening and day students who did not have experience with any telecommunications systems except conventional television, radio and telephone. Detailed technical reports on the construction and results of these surveys are available upon request .

As frequent mention is made in the following section of the Interactive Instructional Television systems (IITV) at USC and Stanford University, a brief description of these systems

follows. The USC IITV system, established in 1972, is designed to serve primarily professionals in engineering, aerospace, and information sciences who wish to take graduate level courses. These students are generally in mid-career and usually are employed fulltime by industries located from 10 to 30 miles from campus. Before installation of the IITV system, these students commuted to the USC campus either in the evening or on a released time basis during the day.

The IITV system transmits live lectures to ten regional centers from the studio at the University of Southern California. Eight of these centers are located at major companies in the Los Angeles metropolitan area; two sites service clusters of companies. Regular academic courses are offered, both credit and noncredit, graduate and undergraduate. Since the program started, an average of 40 courses per semester have been offered by USC over the IITV network. The system includes a talkback capability provided by FM radio transmitters at the remote sites. A daily courier service delivers and picks up homework, exams and other class material.

To join the network, a company installs television classrooms and pays a participation fee based upon the total number of employees at the site. The cost of equipment depends on whether a one-room or a multiple room system is established. Equipment may be either leased or purchased. Although in some cases the company pays tuition fees, most students pay their regular tuition fees plus a surcharge for the privilege of "telecommuting" via the IITV system. The surcharge is generally

greater than the student's out-of-pocket commuting costs, even allowing for appropriate personal income tax deductions. The Stanford University system is essentially identical and was included to provide a more generalizable sample population for the surveys.

B. SURVEYS

A series of five surveys were designed and conducted to obtain information about attitudes toward the telecommunications-transportation substitution. The following populations were surveyed:

- 1) A random area probability sample of Los Angeles County adult residents. The sample was interviewed via telephone and yielded 197 respondents.
- 2) A sample of the USC population of Interactive Instructional Television students enrolled in remote classrooms on-site at their place of employment. Questionnaires were administered in person. These subjects, like their Stanford University counterparts (see below) were primarily professionals in engineering, aerospace and information sciences, taking graduate level instruction during released time.
- 3) A sample of Interactive Instructional Television students enrolled at Stanford University. This sample has similar characteristics as the USC group. Respondents mailed in their answers to USC.
- 4) A comparable group of night time USC commuter students who were seeking advanced degrees in engineering. In some cases, these students also had the option to enroll in Instructional Television classes during the day. In other instances, lack of access to the IITV system precluded its use.
- 5) A sample of regular daytime undergraduate students enrolled at USC. Because of the urban setting of the USC campus and consequent commuting by most students, students were sampled as to their attitudes toward electronic delivery of education.

In summarizing the results of the surveys, the populations

are divided into users and non-users. The first category includes only the IITV students at USC and Stanford University. The second category includes the Los Angeles County general population sample, the USC night students, and the USC undergraduate students.

A series of variables were identified that were common to all the surveys. These variables were organized into clusters of predictive and dependent factors. Measurement was made by means of closed categories on questionnaires, except for those items eliciting personal evaluations. The factors are detailed in Table IX-1. A more detailed discussion of methodology may be obtained in a report entitled: "Consumer Attitudes and Perceptions About Telecommunication Substitutes for Transportation: Final Report," by Gerhard J. Hanneman . [IX-2]

1. Users: IITV Students

The members of this group are characterized primarily by their use of a telecommuting system. Their attitudes toward the system were measured at the beginning of the academic semester and then later in the semester after several months of system use. The two groups, USC and Stanford, showed little variance in attitudes ; therefore, they are discussed as one group except in those instances where notable differences in attitude were detected. There were no significant control group differences to merit covariance procedures.

The average round trip commuting distance for the IITV users (when they commuted to campus) was 27 km. (17 miles). This figure

TABLE IX-1. Survey Factors

<u>PREDICTIVE & DESCRIPTIVE FACTORS</u>	<u>DEPENDENT FACTORS</u>
<u>ITV Factors</u> *	<u>ITV Attitudes (Scaled)</u>
Enrollment status	Effectiveness
Instructor evaluation	Affinity
Purpose of enrollment	Aid to job
Enrollment consequences	Aid to career
	Aid to productivity
<u>Local Transportation Behavior</u>	<u>Transportation Attitudes</u>
Number of automobiles	(Scaled Evaluations)
Travel time	Purpose
Travel distance	Relationship to job
Mode of commuting	Relationship to home neighborhood
Behavior during commuting	Duration
	Travel interlude
<u>Innovativeness/Rigidity</u>	<u>Value and Desirability of Telecommunications Services</u>
5-item innovativeness scale	Interest in and amount willing to pay for:
	- Educational delivery
	- Pay entertainment
	- Telemedicine
	- Electronic funds transfer
	- Civic function access
	- Video conferencing
	- Facsimile
	- Library data banks
	- Self-improvement services
	- Remote job linking
<u>Use and Perception of Telecommunications</u>	
Use of television	
Use of radio	
Use of telephone	
Use of touchtone	
use of CATV	
Use of other media	
* Not pertinent to L.A. County Sample	
The Variables: The variables were organized into clusters of predictor and dependent factors. Measurement was made by means of closed categories on questionnaires, except for those items eliciting personal evaluations. The following factors are common to all studies.	

(CONTINUED NEXT PAGE)

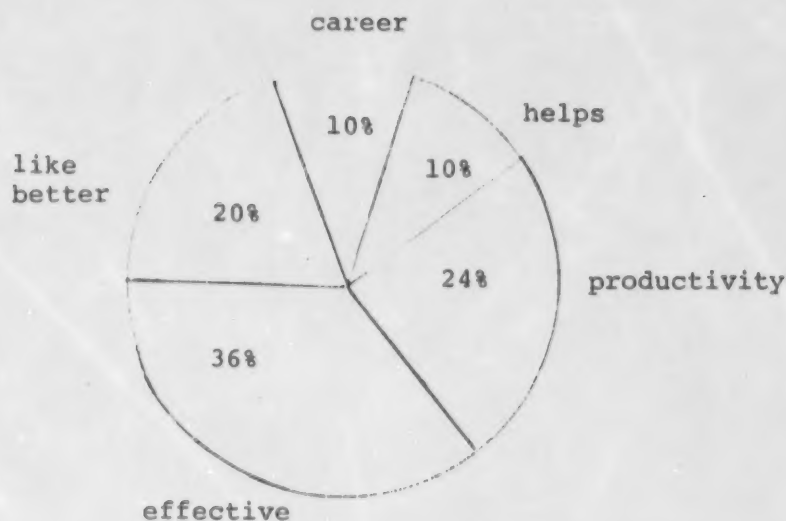
TABLE IX-1. Survey Factors
(continued)

<u>PREDICTIVE & DESCRIPTIVE FACTORS</u>	<u>DEPENDENT FACTORS</u>
<u>Long Distance Business Travel</u>	
Amount	
Purpose	
Substitution potential	
Non-business adjuncts	
<u>Demographics</u>	
Sex	
Age	
Income	
Housing	
Education	
Marital Status	

is slightly below the national average commute to work distance of 30.48 km. (9.4 miles). The pie diagram in Figure IX-1 illustrates the attitudes of the IITV students toward IITV and commuting, respectively.

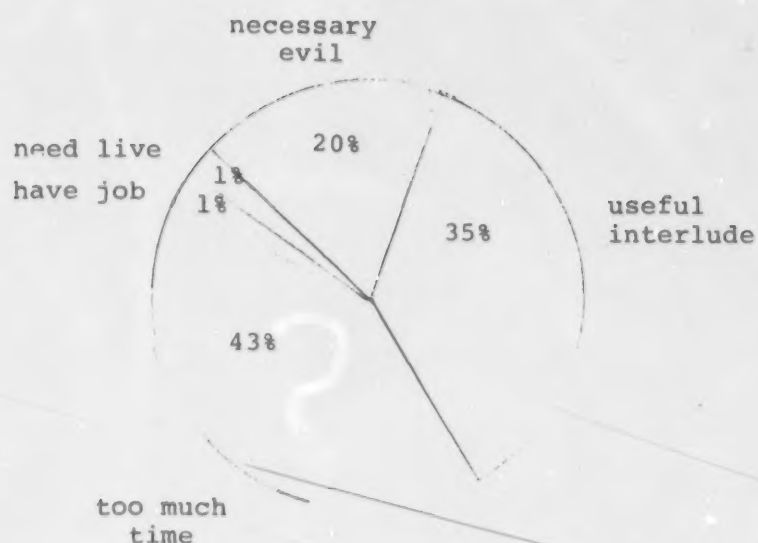
Table IX-2 illustrates pre- and post telecommuting attitudes toward commuting based on two factors: one is an evaluative factor, the other is a pragmatic factor based on home and job considerations. The data indicate that the subjects remained fairly constant in their evaluation of the IITV system. The exceptions are item 4, which shows a trend toward greater affinity over time, particularly by USC participants, and item 1, which indicates a trend toward greater resentment of on-the-job time spent with IITV by USC participants, but less resentment by Stanford participants. It should be noted, however, that this may be partially attributable to differences in coursework as a function of the different university curricula. Further analysis of the data indicated that subjects (55%) tended to feel that they were not missing something of importance on campus by enrolling in the IITV program. Most (60%) felt their attitudes toward IITV would become more positive in the face of a continued energy crisis. In respect to this latter point, it should be noted that the first series of surveys were conducted prior to November, 1973, and it may be postulated that broad attitudinal changes toward commuting and transportation in general may have occurred as a result of the "energy crisis" of late 1973 and early 1974.

Respondents were also asked evaluative questions concerning



1. Participation in IITV will eventually help my career.
2. IITV helps me do my job better.
3. Time spent with IITV takes away from my on-the-job productivity.
4. IITV is as effective for me as in-the-classroom education.
5. I like IITV better now than last month.

FIGURE IX-1(a). Attitudes Toward IITV *



1. Commuting is a necessary evil.
2. Commuting is a useful interlude between home and school.
3. I spend too much time commuting.
4. I need to commute in order to live where I live.
5. I commute in order to have the job that I have.

FIGURE IX-1(b). Attitudes Toward Commuting *

* Code words were not underlined in survey; they are underlined here only for purposes of clarification.

	<u>PRE</u>		<u>POST</u>	
	USC	STANFORD	USC	STANFORD
1. Time spent with IITV takes away from my on-the-job productivity	Agree 43% Disagree 57%	69% 31%	77% 23%	45% 55%
2. Participation in IITV will eventually help my career.	Agree 95% Disagree 5%	97% 3%	100% 0%	94% 6%
3. IITV is as effective for me as in-the-classroom education	Agree 63% Disagree 37%	65% 35%	63% 37%	61% 39%
4. I like IITV better now than last month	Agree 36% Disagree 64%	52% 48%	60% 40%	57% 43%
5. IITV helps me do my job better.	Agree 86% Disagree 14%	77% 23%	86% 14%	84% 16%

TABLE IX-2. Pre- and Post Attitudes Toward Telecommuting

the IITV system, specifically, what improvements they would make. The USC group primarily suggested improved audio/video technology, while the Stanford participants preferred improved administrative functions (courier service). The Stanford group also indicated a need for improved video. Both groups wanted better material presentation by the instructors. Tables IX-3 and IX-4 illustrate student attitudes toward various facets of IITV technology enhancement. Greater importance was placed on two-way audio interaction and delayed replay features. However, using dollar estimation, students indicated they would be willing to pay greatest dollar amounts for better television resolution, instant playback and interruption capability. The conclusion that may be reached from these two sets of data is that students using the IITV systems desire better detail and audio/visual manipulation features that have yet to be developed in most applications of telecommunications, the exception being some specialized 1000 line resolution telemedicine systems. Additionally, these responses indicate that students strongly favor some form of control that is analogous to hand-raising in the classroom.

The following conclusions may be drawn from the survey of the IITV students at Stanford and USC:

- 1) Instructional television as a telecommunications substitute for transportation, offers the IITV user a substantial savings in time and travel. The director of the IITV system at USC, Dr. Jack Munushian, estimated that in the 1974-1975 academic year, the USC IITV system would save 250,000 commuter miles. [IX-3]
- 2) One of the major motivations for participation is a willingness on the part of the participant to complete or expand his or her's educational training; given this

TABLE IX-3. Desirability of Technology

	<u>USC IITV</u>	<u>STANFORD IITV</u>
Two-way Talkback		
Two-way Talkback	4.5	3.6
Delayed Replay	4.7	4.3
Color	2.5	2.3
Classroom Scanning	3.0	2.4

Scales ranged from extremely unimportant (1) to extremely important (5). The higher the value, the more important.

TABLE IX-4. Value of IITV Technology

Average amount extra, per television credit, the student would be willing to pay for: (in dollars)

	<u>USC Undergraduates</u>	<u>USC Evening Students</u>
Interruption Capability	6.84	4.10
Instant Playback	9.04	3.95
Split Screen	2.86	1.05
Better Audio & Stereo	3.05	1.79
Color	4.92	2.24
Real-time transmission	3.71	2.19
Student control of camera	3.04	1.85
Better Resolution	18.07	4.94

motivation, the convenience and ease of the IITV system play a major part in the decision to participate.

A corollary to this conclusion is that IITV students tend to feel that the availability of the system resulted in their taking a more aggressive attitude toward continuing their education;

3) Users of an IITV system show greater affinity over time, indicating that familiarity with the system can favorably affect attitudes toward the system;

4) Over 60% of the participants perceived IITV as being as effective as in-the-classroom education (with Stanford students showing a slight decrease in this assessment over time; comparison of grades and performance ratings by the instructors indicated essentially identical academic achievement for participants in the two modes (IITV and in-the-classroom). This response indicated that no appreciable (or at least quantifiable) loss in effectiveness was occurring as a result of using the IITV system. of use of the IITV system.

An independent survey of the USC IITV participants was conducted by Ms. Kathi Collins, the Administrative Assistant at the USC IITV Center. This survey (Appendix III) supported the conclusion that the availability of the system resulted in a more aggressive attitude toward continuing education, primarily because it was easier to take the necessary courses. The survey also indicated that convenience was a key factor, with most students indicating that time saved was highly important to them and that use of the system minimized time loss from work and disruption of their family life. Finally, Ms. Collins' survey indicated that 50% were willing to pay the cost of driving their car for the IITV service and 24% were willing to pay 50% more than the cost of operating their car for the IITV service.

2. Non-User Populations

The non-user surveys were designed to assess the attitudes of "naive" populations (i.e., people who are unfamiliar with

computer and advanced communications technologies) toward telecommunications as a substitute for transportation. The sampled populations in this group included: a) undergraduate daytime students at USC (some of whom commute from neighborhoods throughout Los Angeles and some of whom live on the campus; b) part-time night students at USC who had had no experience with the IITV system and who commuted to the school to attend classes; and c) a random sample of the adult general population of Los Angeles County.

a) Transportation Patterns

Analysis of the non-user's transportation patterns showed that their commuting behavior was comparable to that of the user populations (Table IX-5). The average round trip commute for the Los Angeles random sample population was 19 miles (the same as the national average in metropolitan areas), as compared with 17 for the IITV students and 17 for USC night students. The USC day student commute to school was lower at 13 miles; however, after adding the miles these students commuted to work (for those who were employed), the day students, along with the part-time night students spent much more time commuting than either the Los Angeles general population or the IITV population.

b) Non-User Attitudes toward IITV

Of the non-user population, the undergraduate daytime students, who traveled the most, were the least receptive to alternate forms of educational delivery. The primary reason for preferring to commute to campus was a preference for the campus

	L.A. Random Sample To Work	IITV-USC To Work	IITV-Stanford To Work	USC Night Students To Campus	USC Day Students To Campus
Average roundtrip time from home to work to campus	46 min.	39	39	33	29
Average roundtrip distance	19 miles	16	16	17	13
Average number of cars have access to	1.2 cars	2	1.7	1.5	1.5
Roundtrip time from campus to work	NA	NA	NA	33	21
Roundtrip distance from campus to work	NA	NA	NA	21	11

TABLE IX-5. Respondents Commuting Behavior

environment and the interaction permitted by that environment. A second reason for a negative response toward IITV was that their work was not amenable to this form of educational delivery, suggesting that undergraduates who were employed primarily in part-time, non professional work, would have difficulty in having access to IITV as it is currently offered.

The part-time evening students , who had the highest average commuting distance of all the groups sampled (17 miles roundtrip to work and 21 miles from campus to work), were more receptive to IITV, with 36% indicating that they would use IITV at work, and 46% indicating they would use IITV at home. Those who gave a negative response cited, again, a preference for the campus environment and interaction with others on the campus.

The Los Angeles County random sample showed that job considerations were an important element in the decision to commute, with 86% agreeing that they needed to commute in order to have the job they had. Commuting was seen as a necessary evil by 68% of the population sampled, but only 32% felt they spent too much time commuting.

Responses to questions on their attitudes toward telecommunications substitutes for transportation to their jobs indicated that:

- L.A. respondents were generally evenly split about their willingness to work closer to home via telecommunications links;
- Those respondents most receptive to dispersion tended to commute the greatest amount, perceived their time as being more important than those who were not receptive to dispersion, and exhibited a mild degree of dogmatism;

- Most respondents prefer working closer to their home but not in it;
- The majority would pay nothing additional per month for this privilege, perceiving dispersion as a fiscal responsibility of the organization;
- Overall attitudes toward commuting were positive or showed acceptance of commuting as a necessary evil; the data indicate that considerations dictate commuting habits such that people would rather give up their residential location than their job to decrease their commuting;
- Commuting is perceived along at least two dimensions; an evaluative factor of affinity and demand; a pragmatic factor of home and job considerations. These two factors are not strongly related.

It should also be noted that the Los Angeles population was relatively unaware of various telecommunications modes and alternate uses of those modes. For example, although 9% of the general population had cable TV, 14% did not know what cable TV was, and 33% more did not know if it was available to them. The indications that close to half of those surveyed showed no interest in cable has significant implications for cable television's growth rate and, consequently, the development of in-the-home services via cable. It clearly indicates need for education of the public about cable; it may also indicate the need for cable franchisees to develop additional services that would attract those non-subscribers who already have adequate television reception.

It is interesting to note that 17% of the general Los Angeles sample reported possessing touchtone telephones - almost double the cable penetration figure. Since the touchtone is complementary to future interactive telecommunications, the market for telecommunications services may lie with this group.

We must assume, of course, that those paying the additional \$1.00 per month touchtone surcharge (General Telephone and Electric's Los Angeles rate) would also be willing to pay the basic cable rate.

3. Attitudes Toward Future Technology Services: Users & Non-Users

Tables IX-6 and IX-7 detail the perceived value of and interest in a variety of home telecommunications applications. Respondents were asked to estimate a dollar value they would willingly pay (in addition to a cable TV charge) for such services and also to indicate (rank) which services they would purchase if they were available now.

It is interesting to note that the dollar evaluation of telecommunications services by the Los Angeles County population and the undergraduate population is much more generous in comparison to the IITV populations. The USC team attributed this difference to the fact the IITV populations have had experience with the technology and are involved in engineering-related disciplines. Consequently, the IITV populations may have a greater sense of the "true" value of the delivery of such services.

Differences are evident between value and desirability ranks:

- Educational Services
- Vocational Links
- Telemedicine
- Pay-TV Entertainment

	VALUE			DESIRABILITY		
	L.A.	IITV	USC	L.A.	IITV	USC
Course Credit	1	1	2	2	9	2
Shopping	6	4	7	9	7	7
Entertainment	4	2	3	1	2	1
Medical	3	3	1	5	4	6
Banking	9	10	10	10	8	9
Government Functions	8	11	9	6	3	8
Visit Friends	5	5	4	3	5+	3
Facsimile	11	9	8	8	10	8+
Data Bank	10	7	5	7	5+	5
Self-Improvement	7	8	6	4	1	4
Job from Home	2	1 USC/ 6 Stan.	*	11	6	*
Visual Access	*	*	7	*	*	8+

* Not Asked

TABLE IX-6, Ranks of the Value and Desirability of Telecommunications Services

		L.A.Pop.	USC & Stanford IITV Participants	USC Undergrads.
Course	Price	16.37	8.60	11.77
Credit	Interest	2	9	2
Shopping	Price	7.75	3.70	4.33
	Rank	9	7	7
Home	Price	11.29	4.85	9.27
Entertain-	Rank		2	1
ment				
Medical	Price	13.19	4.15	23.33
	Rank	5	4	6
Home	Price	3.43	1.55	2.94
Banking	Rank	10	8	9
Gov't.	Price	5.90	0.72	3.01
Functions	Rank	6	3	8
Video	Price	9.47	3.40	7.21
Confer-	Rank	3	5	3
encing				
Facsim.	Price	2.55	1.90	3.15
Print	Rank	8	10	8
Data-	Price	3.06	2.20	5.17
bank	Rank	7	5	5
Self-	Price	6.07	2.00	4.62
Improve-	Rank	4	1	4
ment/ Hobby				
Job from	Price	15.07	9.74-3.11	*
Home	Rank	11	6	*
Visual	Price	*	*	3.69
Access	Rank	*	*	8
+ Scan				
of Print				
Media				

TABLE IX-7. Value and Desirability of Telecommunication Services

are most valued among the Los Angeles population. However, the Stanford group ranks vocational links well below cable shopping in dollar value, perhaps because of the better environmental conditions, lower housing density, and easier commuting in the Palo Alto area.

In terms of immediate purchase behavior, however,

Home Entertainment
Educational Services
Video Conferencing with Friends

are ranked as being most desirable by the Los Angeles general population and the USC undergraduates, while the IITV samples rate

Hobby Services
Home Entertainment
Civic Functions

as being most immediately desirable. The difference in this latter sample is again partially attributable to the fact that they are already enrolled in instructional television at their job location and do not perceive an additional need.

In a factor analysis of the responses of the Los Angeles county sample, two telecommunications factors emerged which elucidate some of the above findings. For example, a major factor explaining the variance in response of this group about telecommunications is one in which value for educational services, banking, entertainment and civic functions cluster together. This tends to indicate that respondents generally evaluate these services along the same underlying dimension, representing a certain amount of social desirability, and group

services which are more passive, i.e., less interactive. When coupled with the desirability data (above) the data indicate that the greatest potential for marketing telecommunications lies within these services.

A second, relatively pure telecommunications factor consists of evaluation of videoconferencing, access to data banks, self-improvement services, facsimile print and home occupational linking. This factor might be labeled the personal role definition factor, which tends to primarily involve interactive services in that most of these services involve active information retrieval or two-way interaction.

These data suggest that while individuals will pay more for services perceived as more complex (telemedicine and vocational linking), desirability of the services is not related to dollar value. The data indicate that:

- There is a market for supplementary educational telecommunications services that would permit people to take refresher courses and high school and college curricula for credit ;

- There exists a market for "pay" television delivery of high quality entertainment not available currently;

- That the underlying motivation for use and acceptance of such services relates to social function and perceived passivity (factor one) or activity (factor two) of user involvement.

As most individuals do not comprehend or desire remote vocational linking (at least in the home), policy and perhaps costs will need to be mandated by the organizations involved. Of course people like to "get out of the house" and may not have the room or privacy to work remotely at home. Other investigations,

and especially demonstration experiments , are needed to test the desirability and effectiveness of such concepts as neighborhood work centers.

Nevertheless, a number of individuals are apparently willing to pay for home vocational linking today. There is no reason why organizations should not encourage, in the near future, the use of phone-coupled computer terminals by personnel who can work with relative task isolation (e.g., computer scientists, finance specialists and secretary/typists).

4. Conclusions

Some overall conclusions related to the development of telecommunications-transportation tradeoff policy are warranted by the survey:

Instructional Television Tradeoffs

- Instructional television, as one manifestation of such a tradeoff, offers the participants a substantial savings in time and travel;

- Even though one of the major motivations for students to participate is the desire to complete or refresh their education, convenience and ease play a major part in their decision to make the telecommunications-transportation tradeoff;

- There is a substantial market for home educational delivery, both among part-time students and the general adult population;

- Most respondents are willing to pay the equivalent cost of driving and maintaining their automobile for such a service.

Local Transportation Behavior and Occupational Networking

- Commuting is evaluated primarily along a time and tolerance dimension and a separate, more pragmatic dimension of relationship to home and occupational environment;

- Occupational stability considerations are more important than others in influencing commuting, in that people would rather move than change jobs if they want to affect their commuting patterns;
- The general adult population (51%) would prefer not to work from their homes, but would work in neighborhood areas closer to home. Most would not pay anything additional for the opportunity to work closer to home, hence making it the responsibility of their employer.

Perception and Use of Telecommunications Services

- A substantially greater percent of the population possesses touchtone telephone service than subscribes to cable television; the touchtone telephone is a readily available technological supplement that is complementary to future technological services.;
- Adults evaluated educational services, vocational linking, telemedicine and pay TV higher than other potential telecommunications services; however, they would immediately purchase, were the services available, pay TV entertainment, educational services and video conferencing services
- The underlying motivation for the use and acceptance of such services relates to social function and the perceived passivity of the man-telecommunications interaction; a second dimension is perceived man-telecommunications activity.

In conclusion, the surveys indicated that the public does not really fully comprehend the potential or operation of pending telecommunication developments. These data also indicate that while individuals are receptive to many telecommunications substitutes, they are not yet ready to fully accept, by a slight margin (51%) remote occupational networking. Of those who are amenable, however, the model of a neighborhood center for remote telecommunication "offices" appears to be the most acceptable.

CHAPTER IX. FOOTNOTES AND REFERENCES

1. Stahmer, Anna E. Casey and Havron, M. Dean, "Planning Research in Teleconference Systems " HSR-RR-73/10-St-X (McLean, Virginia: Human Sciences Research, Inc., September, 1973).

2. Communications Studies Group, Joint Unit for Planning Research, "Miscellaneous papers submitted to the Steering Committee by the Experimental Research Team: February 1971 to May 1971" Ref: P/71135/CH (London, England: University College London, May, 1971).

3. Hanneman, Gerhard J., "Consumer Attitudes and Perceptions About Telecommunications Substitutes for Transportation: Final Report" (Los Angeles, California: University of Southern California, Annenberg School of Communications, 1974).

4. Munushian, Jack, "USC'S Interactive Instructional Television System Expected to Eliminate a Million Commuter Miles Annually by 1975" - news release (Los Angeles, California: University of Southern California, January, 1974).

X. IMPACTS AND POLICY ISSUES

There is a considerable and varied body of literature dealing with the probable impacts of computer and communications technology on society. At the extreme end of the scale are such fictionalized projections as E.M. Forster's "The Machine Stops" and Orwell's "1984." At the other end of the scale are detailed discussions of particular technologies, their individual merits and special applications. In between these two extremes lies a body of literature that summarizes, debates, ponders, postulates and/or advocates, depending on the author and the particular aspect of the subject under consideration.

In recent years, various scholars have undertaken studies of the telecommunications-transportation tradeoff. The most well known of these have been summarized in Chapter II. The main thrust of many of these studies has been that telecommunications probably can be used to replace, supplement, or provide alternate means of performing a variety of functions: transportation to downtown business organizations; transportation to campuses or inter-campus travel; intercity and international travel; delivery of urban services and recreational or cultural events into suburban and rural areas; delivery of various medical services both in urban and rural areas; opening of job markets to the handicapped, etc. More fundamentally, however, the idea of viewing telecommunications as an alternative to transportation raises profound questions about the structure of American

society. We have long accepted transportation, particularly automobile transportation, as being integral to the way of life enjoyed by most Americans. The wide availability and use of individually owned and driven automobiles has been a primary factor in the creation of urban sprawl, freeways, declining use of mass transit, urban air pollution, deterioration of central metropolitan areas, inefficient use of transportation energy by urban dwellers, rush hour traffic congestion, single use central business and residential districts, etc. The automobile and auto parts sales alone account for 17% of U.S. retail sales (X-1). The same availability and use of individually owned automobiles have also permitted (as the proponents of such automobiles are quick to argue) job mobility, expanded use of recreational areas, high employment in critical sectors of the economy, the development of single-family housing developments outside our cities, and rapid, flexible transportation for most Americans.

It is futile to debate the pros and cons of the automobile and the way of living it has produced. There can be no question that the automobile has had and will continue to have a place in American society. The American public is dependent, to a very large degree, on the automobile to perform a large portion of its daily work: going to work, the bank, school, cultural or recreational events, civic offices, stores, the doctor - these and other tasks are primarily performed with the aid of an automobile. Our cities have grown to the point where it is almost impossible to satisfactorily perform those tasks without an automobile. It is not particularly surprising that the modern rite

de passage is the conferral of an driver's license and an automobile.

Until recently, the U.S. economy was operating as if continuous expansion of the automobile industry and increasing dependence on the automobile were destined to be continued indefinitely. However, the well documented, but heretofore poorly acknowledged fact that the oil reserves of the world are finite has begun to cause widespread reevaluation of this concept at all levels of the economy. The key immediate influences in this reevaluation were the Arab oil embargo, which highlighted our dependence on oil, and the consequent "energy crisis" of 1973-1974. As a result of the increasing recognition on the part of public policy makers of the limitations on our petroleum resources, we are now at a decision point as a society; we must decide whether the way of life made possible by the automobile since 1920 will (or can) continue or if we should consider alternate or modified modes of working, communicating and living.

Our reliance upon transportation is traditional. It is accepted belief and custom that going to work is a prerequisite to being able to perform that work. Such Aristotelian assumptions must be eschewed. We are now in an era where technology permits us to communicate between distant points and to perform certain kinds of work in places far removed from the place where that work will be used or stored. We are also in an era where transportation is primarily oil dependent, despite the limited and declining supply of oil. These two observations alone, without further elaboration, should encourage us to consider

alternatives and formulate new approaches. To facilitate informed public policy decisions, the spectra of "problems" and "solutions" must be clearly understood and ranked, in terms of their severity and national utility, respectively. A preliminary "problem" list would include:

- declining availability of petroleum
- national dependence on foreign oil and the associated problems of increasing trade deficits
- transportation-related pollution
- costs of building and maintaining highways
- increased costs of automobile manufacture and operation
- urban sprawl as a result of white collar migration from the cities and the concomitant decline of the inner cities
- loss of time, property and lives from automobile accidents

"Solutions" might include:

- development of nuclear and/or coal energy
- strip mining of the western states to develop oil shale reserves
- use of telecommunications and computer technologies
- reduced oil consumption through rationing or conservation
- development of mass transit
- modified automobile engine design
- combinations of the above

Viewed in this context, telecommunications and computer technologies become an option - an option that permits greater flexibility in defining our national priorities. City, state and national decision-makers should be aware of the possibilities and problems inherent in that option, and, given that awareness, public policy decisions can be made to mitigate possible adverse effects or maximize possible beneficial impacts of the telecommunications option.

Based on the findings of our research for the National Science Foundation, we feel that current communications and computer technology is sufficiently advanced and diverse to be an

economically feasible alternative for transportation in certain industries - the information industries in particular. Further, communications and computer technologies have the potential for acting as a catalyst that could radically change the structure of American society in much the same way that the automobile acted as a catalyst on our way of life during the first half of this century.

For example, consider the possible impacts of telecommunications on the most general level. At least the following areas could be affected by a widespread utilization of telecommunications and computer technologies:

- Industrial structure - its requirements and organization
- Urban Planning
- Availability and use of natural resources , energy in particular
- Environmental quality
- Transportation requirements and habits
- Land use
- Working conditions and patterns of business interaction
- Educational systems
- Government policy and efficiency
- International relations
- Telecommunications industry
- Transportation industry
- Labor policies and practices
- Employment patterns
- Technological development
- Family structure

All the areas above are integral to American life. They are all molded, to some extent, by our national reliance on the automobile; it is reasonable to expect that telecommunications, if used to provide an alternative to transportation, could have a comparable influence in many or all of these areas. Some specific policy issues are discussed below.

A. Transportation

Present and planned mass transit systems and freeways are strongly influenced in their design, their routes, and their service levels by the assumed need to transport workers to and from the central business district. As a consequence, these systems are either hopelessly overcrowded and inefficient during the peak hours, greatly underutilized during the off-peak hours, or both. Further, our urban freeway systems and central business districts are reaching capacity; many major cities frequently voice a pressing need for new or modern rapid transit systems.

The present system is caught in a spiral of trying to match the ever-increasing demands. Two problems predominate: One, the cost of new systems is high, because of the high costs of obtaining new rights-of-way and the perceived need to overdesign for the peak commuter loads. Second, new transit systems generally require combinations of bond issues, federal grants and new taxes to finance the massive new capital investments. Public resistance to this trend is demonstrated by the continuing defeat of these bond and tax issues. Even the infusion of 18 billion dollars of federal mass transit subsidy, which was voted by the U.S. Congress in 1974, appears insufficient to provide adequate mass transit in the near future.

In view of the substantial costs of building and operating such systems, telecommunications would seem to present a viable and logical alternative. Telecommunications could alleviate the need for constant expansion of the transportation system(s) through permitting development of a dispersed network of work

centers throughout the urban area, linked by telecommunications. If workers could travel shorter distances to local office centers, localized transit systems could be used which would be less costly and more efficient. These systems would involve buses or personal rapid transit which, because of the short hauls involved, could be lighter, smaller and less energy consuming than today's standard bus. People could still use freeways and line-haul transit systems for shopping, cultural and sports events, and other activities which might be located at other nodes around the city. New line-haul systems, if needed, would connect nodes at the periphery.

Further, conversion to telecommuting would be a gradual process, which would not require massive new public capital investments. At the very least, large urban areas which are presently under intense pressure to commit money to the development of transit systems (which are primarily geared to commuter transportation) could have considerably more flexibility in the allocation of city, county, state and federal monies if telecommunications were to be used as a substitute for transportation.

B. Urban Development

A set of conflicting forces can be anticipated in the area of land use planning as a consequence of increased use of telecommunications. On the one hand, greater concentrations of growth - regional centers or nodes - within the metropolitan areas are foreseeable. On the other hand, increased urban sprawl

is probable.

Our research foresees evolution of the existing urban structure into a new form of community or communities. In particular, a likely step is the "rural city," which mixes the familiar downtown business area and urban living, with the result that central business districts would no longer be predominately single use in their design. Instead of monolithic buildings devoted solely to office use, new ones may evolve with a mixed selection of offices, living quarters, parks, and entertainment facilities. City dwellers could enjoy some advantages of small town living in that they could live and work in the same general area; at the same time, they could enjoy the cultural advantages and activities of a major metropolitan area. Decentralization, through the use of telecommunications, would facilitate the growth of these "rural cities" at various points through the metropolitan area.

As with all cases of increasing freedom of choice, however, we begin to worry about the point where freedom may become license - the urban growth equivalent of the "tragedy of the commons." [X-2] One of the clear potential results of the greater ability to relocate because of improved and cheaper telecommunications technologies, is that people will move to areas of great scenic beauty or recreational potential in such numbers as to destroy the resource they moved to be near. The choices are to risk the destruction of such major natural resources through inadequate planning for this possibility or, through careful planning, provide scenic and recreational areas

in cities and protect our natural resources. It seems possible that as people spend more time living in suburban areas, they may take more care in providing park lands in these areas, thus avoiding urban monotony.

It should be noted that land use and development is primarily a local, or at best a regional concern. To date, local planners have oriented city development around the existence of a central business district. In recent years, revitalization of decaying central city areas has become a major trend. Considerable amounts of money and effort have gone into urban renewal programs and the introduction of improved transportation facilities into the central areas. As indicated earlier, new rail rapid transit systems are being planned throughout the country, most of which are designed to increase the centralization of the cities by moving people, primarily commuters, downtown more efficiently. The momentum of this new downtown movement is great. City planners will have to examine this concept in light of the new telecommunications technologies within a few years or they will lock themselves into the present pattern. The policy decisions of city planners are particularly crucial, since the constraints on and impacts of decentralization are numerous in several critical planning areas, including zoning laws, taxation, design of city service systems, location of public buildings, etc.

C. Energy

One of the major impacts of the substitution of

telecommunications for transportation is in the area of energy conservation. Dickson and Bowers [X-3] have performed some rough calculations on energy conservation aspects of the use of the video telephone as a substitute for jet transportation over long distances. They indicate that the ratio of energy use varies between 2.7:1 and 8:1, depending on the contact time between individual participants in a face-to-face or the alternative video telephone-to-video telephone discussion. Our own more detailed investigations indicate that the equivalent energy use ratio between a commuter using a private automobile and the same commuter telecommuting is approximately 26:1. Consequently, the replacement of urban commuting by telecommuting (at least telecommuting carried out at telephone bandwidths) could result in a net reduction in U.S. energy consumption of 8.2 billion kilowatt hours annually for each percent of the urban commuting work force engaging in the substitution. Conversion of about 10% of the urban commuter work force to telecommuting would save about 150,000 barrels of gasoline per day. Since federal figures for U.S. motor gasoline imports in 1974 indicated a level of approximately 100,000 barrels per day, there are clearly energy incentives to telecommuting. [X-4].

A subsidiary aspect of this method of energy conservation is that a substitution of telecommunications technologies for transportation would induce a proportionate change in the requirements for the type of delivered energy from gasoline to electricity. Hence, one of the higher order impacts to be considered is the effect on the demand for increased supplies of

electrical energy and the retroeffect of the impact on the speed of acceptance of telecommunications substitutes caused by the inevitable delays in adding new electrical power plants in an urban area. Since it takes about eight years from initial negotiation to initial operation of a conventional electrical power plant, and up to eleven to twelve years for development of a nuclear power plant, some attention must be paid to the dynamics of interaction between these related technologies. Since power systems regulated by the government on state, regional and federal levels, it is apparent that government energy policies are critical if adequate electrical energy supplies are to be available. Present government regulations can create up to a 15 year delay in the construction of fixed power plants; federal policy in this area would clearly need to be reviewed before government policy makers could encourage substitution of telecommunications for transportation.

D. Environment and Resource Management

The relationships between energy conservation and the potential effects of telecommunications substitutions have already been discussed. However, a major higher order impact of both the substitutions and the potential improvement of transportation flow is the possibility of reducing pollution. Since urban automobile traffic constitutes approximately 80% or more of the contribution to urban air pollution, it is clear that significant reductions in the amount of urban traffic or improvement in traffic flow could have material effects on

reducing pollution and improving air quality (since much of the pollution is caused by acceleration, deceleration, and idling of vehicles). [X-5]

One factor which has not been adequately explored is the change in use of irreplaceable resources brought about by the substitution of telecommunications for transportation.

Transportation and telecommunications technologies use different sets of natural resources and the base for each is in varying abundance. Consequently, one of the possibilities that should be examined is the need for limiting the growth either of telecommunications or transportation because of excessive use of particularly scarce resources. Policymakers should be cognizant of the fact that encouraging the use of either technology may result in excessive use of potentially scarce resources.

E. Telecommunications

The development of telecommuting requires a policy environment which aids, or at least fails to hinder, the development of innovative applications of computer and telecommunications technology. National transportation and telecommunications policies are designed, in principle, to fulfill the functions of providing for the net public good by regulating some types of economic activity through such means as imposing rate structures, limiting competition, requiring that services be provided in unprofitable areas, and enforcing standardization of various sorts. In Canada, all forms of telecommunications are subject to national government regulation.

In the United States, there appear to be some exceptions to this rule, which may enhance the development of telecommuting, i.e., a local telecommunications company that is not engaged in interstate commerce could provide a private data network linking regional centers in a conurbation without being subject to federal regulation. That is, the private network described in Chapter VI could be owned and operated by a local common carrier (such as a cable company), leasing its services to business firms or other organizations in each regional activity center. Aside from this new possibility, it may be advisable for national governments to consider detailed policy options, which would enhance the development of telecommuting, such as encouraging or requiring the installation of broadband telecommunications networks for data traffic between regional centers. At present, the rules governing the rates, data privacy and service availability of public data networks are relatively undefined for new telecommunications systems, particularly at the local government level. These issues must be resolved if any wide applicability and use of those systems is to be possible.

F. Labor and Management Policy Issues

Several management and policy issues will have to be resolved. Decentralization through communications offers opportunities for new work styles that are not based on the 40 hour, nine to five work week. Managements could have the opportunity, through telecommunications and decentralization, to obtain new sources of labor, including housewives and high school

students to perform these tasks.

It is likely that in the near term, routine work will continue to be performed in groups with line-of-sight supervision, although computer terminals make work at home entirely feasible. If entire groups are scattered, then individuals may find, or at least feel, that promotional opportunities in large organizations are more restricted because they will be limited to their neighborhood center rather than being able to move from group to group up some promotional ladder. A major step then would be a move from a local work center to the company headquarters.

The question of productivity is a serious one, and research still remains to be done in this area. To date, a scattered series of studies indicate that worker productivity levels resulting from the use of telecommunications remains at least as high and, in some cases, increases over that of the monolithic central organization. The individual business firm would be expected to take advantage of this productivity increase by decreasing or limiting growth of its personnel complement. Yet past history seems to indicate that where reduction in employment has occurred, new job opportunities in other economic areas have increased. The net result is still an increase in productivity for the working population.

An important issue in decentralization is the enforcement of local hiring. If a company fragments its offices to a limited number of locations, much of the social benefits of reduced travel to work may be lost. Even if the initial assignment of

people is to the work center closest to their home, changes in residence do occur. For example, in minority areas, obtaining regular employment may prove to be a stimulus for individuals to move. Recent court rulings concerning city employees living outside the city tend to give an individual the absolute right to work and live to wherever he chooses. It is therefore unlikely that companies will be able to discharge employees simply because they have changed residence.

Several alternative strategies are possible, depending on how decentralization occurs. If the remote work centers are designed so that each center is a fragmented one, performing a single function (e.g., health insurance claims or policy underwriting in our case study example), then if an employee moves the company could transfer him to the department whose work center is closest to him. This is, however, undesirable because slots may not be available and because training in the new task and training of a replacement would be required.

The more sophisticated dispersion approach, which appears feasible in terms of current technology, would have people who are in different departments located in the same work center. Hence, each department or function would be physically distributed among a number of work centers. Then, if an individual moved, he could continue in his present job but at a different location. If a particular work center became too small, it could be closed down, since the capital investment is low; if a work center becomes overcrowded, it can be split into two or more centers that are more propitiously located. Distributing

departments among work centers may pose problems in supervision and training, but these do not appear to be insurmountable, although, as pointed out in Chapter IX, much research remains to be done on the detailed human interaction aspects of remote supervision.

If local hiring decreases turnover, then two conflicting trends appear. The reduced turnover promotes work stability and reduces training costs. However, in most companies, salaries increase with length of service and average wage rates may go up as a result.

Telecommunications presently represent an out-of-pocket cost to the firm, whereas the transportation costs of employees do not, at least superficially. In making cost/benefit analyses, care must be taken to put this question in proper perspective. Transportation costs for going to work are implicitly included in wages. Many firms pay premium wages for their downtown employees compared to those who work in outlying areas. Furthermore, higher office space costs are often incurred in downtown areas. Which set of costs predominates in the decentralization decision will depend on the situation and attitudes of individual companies.

Management issues overlap public policy issues. As mentioned earlier, government regulations that specify that each place of work is to be considered separate for the purposes of unionization and equal employment opportunities enforcement make decentralization unattractive to employers. In fact, one can devise scenarios in which one ethnic grouping is brought into another ethnic area and vice versa simply to meet equal

employment opportunities standards, thereby defeating the goal of reducing transportation requirements. However, if decentralization is arranged so that employment is provided locally for all groups in the city, the decentralization concept offers new opportunities. For example, new flexibility is offered through telecommuting to workers in minority areas who, because they are unable to afford automobiles and because public transportation is inadequate, are otherwise unable to find jobs. Telecommuting not only may be able to provide the basic job opportunity but, through reduction in unemployment, will act to upgrade the minority areas.

Management will also have to decide whether it will use a private or a public communications network. The former ensures information privacy but possibly at a higher cost than a public network. To a large extent, government regulatory policies will have a major impact on this decision.

G. Societal Impacts

On a very broad scale, decentralization through the use of telecommunications would have considerable impact on individuals. The creation of smaller, neighborhood work centers could create more "community identity" both for the individual and the business organization. With a decrease in commuting time and distance, individuals would be able to spend more time with their families and/or use healthier means of getting to work, e.g., bicycling, walking. Local offices would also permit more women with children to work on a part time basis. A reduction in human frustration with traffic congestion and a reduction in air

pollution is also foreseeable. The net result of these changes should be a favorable change in the quality of life for the individual, a change predicated on a healthier environment and a heightened feeling of identity with his community, his family and his co-workers.

H. The Influence of Federal Policy

A central aspect of the development of policy recommendations is the realization that quite complex forces, not necessarily under directly federal control, are directing the choices between transportation and telecommunications. For example, our research has shown that there are substantial incentives to business enterprises located in urban central business districts to relocate in regional and/or suburban business centers. A primary incentive is the increasing difficulty of acquiring competent clerical personnel who are able or willing to work in the central business district. Transportation difficulties are a major factor in this problem. Nevertheless, the decision to decentralize, using telecommunications technology to interrelate among separated organizational subunits, is made on a corporation-by-corporation basis and on criteria which appear to the decision maker to be tangentially related to available technologies. Because of the continuing and increasing dysfunction of public transportation systems in major metropolitan areas, the difficulty of commuting to and from central business districts will serve to accelerate these phenomena in the future in an essentially spontaneous set

of occurrences.

The influence of federal policy on this process is much more subtle than, for example, the development of defense resources, where immediate cause and effect can be determined. If the increasing substitution of telecommuting in the conduct of business offers positive societal benefits, a variety of governmental policy actions must be examined to determine their relative effectiveness in enhancing this benefit or, where disbenefits are found, in discouraging undesirable substitutions. For example, the Carterphone and related decisions of the Federal communications commission have spurred the development of specialized common carriers and the computer time sharing industry, which permits substitutions such as telecommuting for inter-urban travel. A similar situation is likely to occur at state and city government levels. Our research indicates that conditions are right for a new kind of specialized common carrier, an urban telecommunications infrastructure, which provides dedicated communications networks within a metropolitan area. Because its network neither extends beyond nor imports from nor transmits signals out-of-state, this infrastructure does not fall under the regulatory jurisdiction of the Federal Communications Commission. In general, state and local franchising agencies which could have authority, are currently unequipped to deal with the regulatory aspects of such common carriers. Nevertheless, the availability of high quality data services in metropolitan areas can provide a strong factor toward accelerating the dispersion of many types of businesses from

central business districts. The consequences of this dispersion on transportation system design can be quite significant.

The above policies and other seemingly disparate policies (e.g., foreign policy toward oil producing nations, economic policies toward gasoline rationing, labor bargaining laws, corporate tax structures, etc.) are fundamental to the future of telecommunications as an alternative to transportation. It is a major recommendation of this report that further policy research be performed to develop greater understanding of the impacts and interrelations of federal, state and local policies that affect the development of telecommunications as a substitute for transportation.

CHAPTER X. FOOTNOTES AND REFERENCES

1. U.S. Bureau of the Census, Statistical Abstract of the United States (Washington, D.C.: U.S. Government Printing Office, 1972), p.740.

2. Hardin , G., "The Tragedy of the Commons," Science, Vol. 162, December 13, 1968, pp. 1243-1248.

3. Dickson, Edward M. and Bowers, R., The Video Telephone, A New Era in Telecommunications: A Preliminary Technology Assessment (Ithaca, New York: Cornell University, June, 1973).

Prepared for the National Science Foundation , Research Applied to National Needs (NSF-RA-S-73-004. Dr. Dickson is now at Stanford Research Institute, Menlo Park, CA 94025.

4. U.S. Senate Committee on Interior and Insular Affairs, Current Analysis of Petroleum Supplies for First Quarter 1974 (Washington, D.C.: U.S. Government Printing Office, 1974).

5. McHale, John, "World Facts and Trends " (New York: Collier Books, 1972), p.17.

APPENDICES

Appendix I

DEVELOPMENT OF POLICY ON THE TRANSPORTATION-
TELECOMMUNICATIONS TRADEOFF

Abstract

The burgeoning use of wideband telecommunications in the business and educational fields portends substitution of telecommunications for transportation of major proportions. A project is proposed to develop a capability within the University of Southern California for development of recommendations for telecommunications policy related to the telecommunications-transportation tradeoff. The policy recommendations will be directed to federal, state, regional and local government agencies.

The first year of the project will be devoted to development of a descriptive model of a typical telecommunications-transportation tradeoff situation, conducting a study of the motivational aspects of the tradeoff, and development of proposals to other agencies for continued effort. The descriptive model will illustrate the principal factors in the decision by a typical member of the "knowledge industry" - an insurance firm - to substitute television for transportation. The motivational study will assess the reasons for selection of telecommunications, or transportation, by participants in companies having access to the USC Interactive Instructional Television Center. Information gained during these studies will be used to develop proposals for further effort.

Four organizations will participate in this effort: the Annenberg School of Communications, the Center for Futures Research in the Graduate School of Business Administration, the School of Engineering, and the Office of Interdisciplinary Program Development under the Vice-President, Academic Administration and Research.

APPENDIX II

Scenarios

SCENARIO I

J.J. JONES, executive manager of the Benington National Bank, sat down in front of a green CRT. He opened his User's Guide and turned to the section "Computer Conferencing System." A table of system commands opened before him.

After glancing at the table, he typed on the keyboard:

JONES 421-92-4213
ENTER CONFERENCE AGENDA
MENU

He followed this with a press of the PROCESS key.

Jones read the screen as it returned the computer's response:

THE DATE IS NOVEMBER 28. THE TIME IS 9:00.
NO OTHER CONFERENCE MEMBER IS PRESENTLY
INTERACTING WITH THE SYSTEM. IF THIS
USER STATUS CHANGES YOU SHALL BE INFORMED.

MENU

DO YOU WISH

- 1 A SUMMARY OF THE CURRENT STATUS OF
CONFERENCE MEMBERS
- 2 AN UPDATE ON CONFERENCE MESSAGES SINCE
YOUR LAST CONFERENCE INTERACTION
- 3 TO SEND A PRIVATE MESSAGE TO A
PARTICULAR MEMBER OR SUBGROUP
- 4 YOUR PRIVATE MESSAGES
- 5 A PARTICULAR MESSAGE

PLEASE TYPE THE NUMBER OF YOUR CHOICE *

Jones responded by typing a "1" followed by the process key.
The computer returned:

THERE ARE PRESENTLY 124 MESSAGES ON THE

CONFERENCE LIST. THE LAST MESSAGE WAS
ENTERED BY SUMNER AT 4:20 PM NOV 27. THE
CURRENT STATUS OF THE CONFERENCE IS
SUMMARIZED BELOW:

CONFERENCE MEMBER	LAST ON	LAST MESSAGE PROCESSED
GIBBS	9:35 AM NOV 27	107
JONES	9:47 AM NOV 26	100
PETERSON	11:05 AM NOV 27	123
ROSS	10:01 PM NOV 27	125
SUMNER	4:30 PM NOV 27	124 *

Jones read the status report and typed "MENU." MENU
reappeared on the screen. Jones responded with a "4."

THE FOLLOWING MESSAGES HAVE BEEN SENT TO
YOU SINCE NOV 26, 9:47 AM:

SENT 4:15 PM NOV 27

SUMNER - PETERSON SUGGESTS IN MESSAGES
110, 117, 119, 121 THAT THE INKBLOT P'N COMPANY
WILL FOLD IN JANUARY. AS YOU WILL SEE, HE
USES BANKRUPTCY AS AN ARGUMENT FOR BUYING
INTO NEVERDRY PENS. I AM SKEPTICAL. AS I
RECALL, YOU KNOW P.C. CURTIS AT INKBLOT.
SEE WHAT YOU CAN GET FROM CURTIS BEFORE THE
OCTOBER 1 GENERAL MEETING.

NO OTHER MESSAGES. *

Jones left the terminal and walked over to the phone, placing
his call to P.C. Curtis. Curtis was not in, but would return
his call shortly. He returned to the terminal and typed "2."

Message 101 appeared on the screen along with the name of its author. It was followed by:

WHEN YOU WISH TO CONTINUE TYPE C

Jones read the message, typed C and 102 was displayed. He proceeded in this manner until reading message 122. At this point he decided to insert a comment. Glancing at the command table, he typed an IC for insert and continued.

LAST MESSAGE PROCESSED: 122 - ROSS

WHAT IS YOUR MESSAGE?

126:

Jones' message began

REFERRING TO 122. . .

Jones read through his message and used an EDIT command to alter part of it before tapping the PROCESS key. Message 123 filled the screen. Jones continued through the conference. Completing 126, he adjoined another comment which became 127. The phone rang. The call from Curtis was through. Jones went to his desk and leaned back in his chair.

"How's business, Pam?" he asked.

SCENARIO II

"Myra, could you send this memo out to all the other divisions, please?"

"Yes, Mr. Hart."

As she typed the memo on her terminal, the words appeared on the viewing screen before her.

MEMO FROM COLLECTIONS DIVISION OF THE J.T.C.
INSURANCE COMPANY

TO ALL DIVISIONS

CONCERNING NEW POLICY ON LATE PAYMENTS

DUE TO THE INCREASING NUMBER OF OUR CUSTOMERS
WHO ARE MAKING PAYMENTS THREE TO FOUR DAYS
PAST THE DEADLINE, WE ARE EXTENDING. . .

After proofreading her copy she typed in the send commands and waited for the signal telling her that it had been received by all the divisions. Then she punched the store instruction and the memo was dated and recorded in the central data files.

As the images faded away, a new message appeared:

REQUEST FROM ACCOUNTING DEPARTMENT FOR FILE
OF EXPENSES INCURRED PREVIOUS MONTH.

Myra stood up and walked over the cabinet which stored all the magnetic tapes. As she was looking for the correct tape, Bob, who handled overdue payments, came up to her.

"Hi, Myra, how are you doing?"

"Oh, alright, I guess, except for my asthma and the poison ivy. I went to see the doctor Tuesday and he said that. . ."

"Uh, Myra, when you have a free minute, could you send out for the file on John Butler, account number G97423-B?"

"Sure, I'll have it for you in a few minutes."

"Thanks, I'll be back to pick it up."

Myra found the right tape and mounted it on a tape drive. Then she seated herself back at the terminal.

ATTENTION ACCOUNTING DEPARTMENT

SIGNAL WHEN READY TO RECEIVE BULK INFORMATION
TRANSFER

READY

Within seconds, the transfer was completed.

By the time the request for information had been filled, Bob was back to pick up the newly printed output. Myra was now faced with the choice of either updating the current list of overdue payments or cross-checking today's collections with the bank to find the bad checks. Since it was nearly lunchtime she decided upon the former.

UPDATE ON FILE OF OVERDUE PAYMENTS
TO CENTRAL DATA FILES
FOLLOWING - LIST OF PAYMENTS RECEIVED TO DATE

FILE 382-C
SEND AND RESPOND

As she finished typing, one of the tape drives started up and soon after the card puncher started producing reminders to be mailed.

"Hey Myra, ready for lunch?"

"Sure Sophie, soon as I collect these cards. Italian or the new taco place?"

Myra finished collecting the cards, typed a message and left.

COLLECTIONS DIVISION INACCESSIBLE.
OUT TO LUNCH.

SCENARIO III

As he turned over, rays of sunlight broke his sleep. He jabbed a button on the clock radio.

". . .closing the trade, Campanis predicted that the summer would be a hot one indeed. This is Herb Martin from the work of sports. . .and this is radio K-WOW. It's 2:35 and a big, bright beautiful Tuesday afternoon. . . ."

He was out of coffee filters and hunted through the garbage can for a used one. Finding one in an empty milk carton, he fished it out, carefully rinsed it, and folded it into the coffee pot. The water wasn't ready, so he walked over to the phone and dialed the library.

"Hello. . .this morning I dialed for microfilm reference 42328 and it didn't come through. . .when did I call? About 3 A.M. . .but my indicator light didn't go on . . .I'll have it checked then. When will the system be up again? . . . OK, I'll dial for it."

As he drank his coffee, he read through the papers covering the table. Setting down the last page he smiled. "Coates will like this."

- - - -

John Coates leaned back in his swivel chair. As he stretched his arms behind his head, he thought about taking a short nap. He had been working since 9 A.M. and was beginning to tire. He opened the door of his study. Through the living room window he could see Mary, his wife, backing the car out of the driveway. The phone in his study rang.

"Hello."

"Hello, Dr. Coates. This is Sam. I did some work this morning that I'd like you to see."

"OK, Sam." Coates flipped on the screen above the phone carriage.

"This follows directly from our latest results on p-adic L functions. I think Tate may have conjectured it in a lecture series, but the library was down this morning so I couldn't check."

As Sam wrote the theorem and its proof on a white surface it was beamed back to Coates. Sam's explanation was broken several times as Coates modified or questioned the steps.

"That's good, Sam. It should be in your dissertation, so you had better check Tate's work. . . .You know, this suggests that functions satisfying this property might be constructed in the following way. . . ."

As Sam turned on his screen, Coates' message began to sprawl across it. Sam began to take down some notes.

"OK, I'll try it. I'll call you back if it works. By the way, I dialed in for your seminar lecture yesterday. It was quite good. . . ."

They went on to discuss the seminar, exchanging more ideas over the video channel. Breaking a concluding pause, Sam said,

"I think I'll go have some breakfast."

"I'm going to be occupied this evening," Coates said. If anything develops, call me tomorrow.

Coates hung up the phone, pressing the NOT AVAILABLE button on its carriage.

"Guess I'll take that nap," he thought.

SCENARIO IV

Franklin W. Merriweather seated himself in front of his dry toast and black coffee brakfast. He unfolded the morning newspaper.

"COASTAL BOARD PERMITS EXPANSION OF EDISON FACILITIES
AT SAN ONOFRE"

Jill and Jacqueline Merriweather rushed into the kitchen.

"Bye, daddy."

They grabbed their lunches and fled through the back door.

The phone rang.

"Hello, darling. Listen, I forgot to tell you that Margaret and Phillip are coming for dinner tonight. Would you take a roast out of the freezer? I won't be home until 4:30 or 5:00. I'm holding a parent conference. If you have time, put the meat in the oven around 4:00."

Frank entered his study. A pile or reports covered his desk.

"I really should file all that stuff," he thought.

As he sifted through the papers, a hand-written note caught his attention:

*Before Policy Conference on December 12: ANALYZE STATISTICS
ON OD ACCOUNTS.*

Frank uttered a mild expletive. "I forgot all about this." Turning to the CRT which rested to the right of his desk, he typed:

MERRIWEATHER 653-88-1773
ENTER CONFERENCE POLICY
MENU

The computer responded:

THE DATE IS DEC. 12. THE TIME IS 9:04 AM.
THE POLICY CONFERENCE WILL BEGIN AT 10:00 AM.
THERE IS NO MENU. WOULD YOU LIKE ONE? (YES/NO)*

This time the expletive was slightly stronger.

Frank swung around to his littered desk looking for his USER'S GUIDE. Before finding it, he remembered the correct call. He turned to the screen. The question still stared at him.

NO

The screen's message faded away. Frank typed:

ENTER CONFERENCE POLICY AGENDA
MENU

The computer responded:

THE DATE IS DEC 12. THE TIME IS 9:13 AM.
NO OTHER CONFERENCE MEMBER. . . .

Frank punched the ATTENTION key, abruptly stopping the printout. He then typed 4 and the fading screen renewed itself:

THE FOLLOWING MESSAGES HAVE BEEN SENT
TO YOU SINCE DEC 10, 4:32 PM.

SENT 2:00 PM DEC 11

SYMORE - MELBOURNE IN MES. 192
SAYS THAT OUR HOMEOWNER'S LOAN PROCEDURE
LACKS BRANCH CONSISTENCY. I HAVE NOT BEEN
ABLE TO CONVINCE HIM OF THE IMPORTANCE OF
REGIONAL INDEPENDENCE. HE IS GOING TO MOVE
FOR TIGHTENING.

NO OTHER MESSAGES*

Frank typed 2 and read through new conference messages as they sequenced on the screen. After reading the last message, he again went in search of his USER'S GUIDE. After shuffling through several drawers and heaps, he sighted it resting on top of the terminal. He grabbed it and fell back into his chair.

"Divisions. . .divisions. . ."he muttered as he thumbed through the guide. A tree indicating the Benington National Bank structure rested below the title DIVISIONS. Frank turned

back to the terminal.

ENTER DIVISION CHECK PROCESSING-STATISTICS

The computer responded:

THERE IS NO SUCH LABEL IN OUR LISTING.
DID YOU MAKE A TYPING ERROR? (YES/NO) *

NO

The computer answered:

CHECK DIVISION LISTING PAGE 42 OF USER'S
GUIDE *

Frank chewed his thumbnail and muttered softly. After checking his watch, he picked up the phone and dialed a number. A voice answered:

"You have reached network information. Please hold the line. An operator will be with you momentarily."

Music filled the interlude. Jones rocked nervously in his chair. The voice broke the melody."

"Please hold the line. An operator will be with you momentarily."

Frank slammed the phone back in its cradle, terminating a saccharine version of "Up, Up and Away." He spun around and stared at the terminal.

CHECK DIVISION LISTING PAGE 42 OF USER'S
GUIDE. *

Franklin W. Merriweather started on the other thumbnail as he checked the manual again. "Maybe I made a typing error," he mumbled. He retyped:

ENTER DIVISION CHECK PROCESSING-STATISTICS

and the computer responded promptly:

THERE IS NO SUCH LABEL IN OUR LISTING.
DID YOU MAKE A TYPING ERROR? (YES/NO) *

NO DAMNIT

Frank glared at the screen as it printed:

NO DAMNIT NOT A VALID COMMAND.

PLEASE ANSWER YES OR NO.

Frank Merriweather was now audibly abusive. He grabbed the telephone again and dialed.

"You have reached network information. Please hold the line. An operator will be with you momentarily."

SCENARIO V

Paula stepped into the last available space of the elevator.

"42 please," she said to the elevator attendant. As she stepped out of the elevator she heard someone call her name. It was Sharon.

"Hi, Sharon. Did you have a good time last night?"

"Oh, it was okay, I guess."

Sharon and Paula walked down the red-carpeted corridor Sharon stopped in front of a door addressed: Bennington First National Bank - Check Processing Division. She turned to Paula before entering.

"Lunch?"

"Sure."

Pauls continued down the corridor to the last office of the wing: Lifetime Insurance - Policy Updating Division. Opening the door, she was met by the commotion of morning ritual. She walked over to a crowded mailbox area. In the cubbyhold addressed to her, she found a brown paper packet.

"Hi, Paula."

"Hi, Kathy,"

Kathy found her packet and they both walked down an aisle bordered by 30 CRT terminal stations. They reached their neighboring stations and were quickly seated, Paula opened her packet, pulling out a cartridge of microfiche. She put the cartridge into a reader which rested to the right of her terminal keyboard. A series of checks filled the screen as she turned on the reader. Beneath the signature of each check was a series of numbers indicating the signee's account number. Paula turned on the terminal and typed:

JENKINS 1672-45-2241

RECORD UPDATING - POLICY FORM 2018

The computer responded:

ENTER ACCOUNT NUMBER/INFORMATION CODE *

After looking at the first check, Paula typed:

41721/24

The computer responded:

ENTER AMOUNT *

Paula typed:

\$78.97

and the cycle began again with

ENTER ACCOUNT NUMBER/INFORMATION CODE *

Before entering the next number, Paula turned to Kathy and said,

"Muriel and Will are seeing each other again."

"NO," said Kathy. "Really? What's Sally going to do about it?"

When Paula finished the next update she turned to Kathy.

"I don't know," she said. "I don't think she'll give Will a divorce."

Kathy finished the first page of microfiche and pushed the PAGE button of her reader. A new series of checks filled the screen.

"She should. Honestly, she's the one who broke up Muriel and Will in the first place. It was a good marriage before she came along."

"Yeah, but Will is very attached to the baby and if he goes back to Muriel, Sally won't let him have Johnny."

Kathy was about to reply but Paula stopped her.

"Wait a minute."

Paula looked at the number at the corner of her screen and the number indexing the check she was presently processing. They coincided.

"OK, go on. I though I had skipped one."

Kathy punched PAGE again and said: " Well you know, Will wouldn't be so attached to that baby if he knew it wasn't his."

"What!" said Paula.

"Sure," replied Kathy. "Didn't you know that? That baby is Hank's."

"Hank? Will's brother!!?"

"Sure," said Kathy.

"But Hank's such a creep! Did you . . ."

"Wait," said Kathy. "I just entered the right amount on the wrong account." She pressed the CHECK button on her terminal and the entire series of accounts she had processed from the microfiche page appeared on the screen, each number followed by the money entry she had typed. She checked the microfiche accounts with those on the CRT and said,

"No, it's right. What you going to say."

"Well," said Paula. "I was just going to tell you that that creep joined Hell's Angels."

SCENARIO VI

Mr. Hart had been at this video phone often to obtain his bank statements, but this time it was different. He was worried. He wanted a loan.

He put in his quarter and dialed the number of his bank. A young woman's face appeared.

"United American Bank. Good morning. May I help you?"

"My name is Jonathan Hart and I would like to talk to someone about a loan."

"One moment, please, Mr. Hart, and I will connect you with our Loan Department."

A picture of the U.A. Bank appeared on the screen as Mr. Hart was put on hold. In about thirty seconds a new face materialized.

"Russ Johnson is my name, Mr. Hart. Now what seems to be the problem today?"

As Johnson listened, he could see Hart on the upper part of his screen, while on the lower half, data describing Hart's account with the bank began flashing onto the screen.

HART, JONATHAN T.

ACCOUNT NUMBER 025-69801-05

CURRENT SAVINGS BALANCE \$697.83

CURRENT CHECKING BALANCE \$187.51

AVERAGE MONTHLY BALANCE \$150.28

NUMBER OF OVERDRAWN CHECKS 0

After Hart had finished, Johnson started in with the usual questions:

"Have you ever had a loan granted before?"

"Sure. I had a federally insured loan of \$500 while attending college. I paid that back as soon as I started working."

This was confirmed on his viewing screen. Johnson now began typing in the details about Hart: family status, job, income, former employees, etc. As this was being completed, the results

of the computerized credit check began coming in.

HART, JONATHAN T.	692-58-6211	
NO BAD CHECKS		
MAJOR CREDIT CARDS		
BANKAMERICARD	\$300/MO LIMIT	GOOD RECORD
MAY CO		GOOD RECORD
SHELL OIL CO		GOOD RECORD

"Well, Mr. Hart, you have never had a major loan before, but you seem to be a good risk. I think we can grant this loan request. Now, let me calculate the different montly rates for you.

As the figures appeared on his screen, Johnson read them off to Hart.

LOAN OF \$10,000.00
\$1,000 MONTH FOR 11 MONTHS
500 MONTH FOR 23 MONTHS
250 MONTH FOR 47 MONTHS
125 MONTH FOR 95 MONTHS
75 MONTH FOR 160 MONTHS

They discussed which payment schedule would be best for him and decided upon the optimum monthly payment. When the details had been clarified, copies of the agreement were printed up at the video phone automatically. Hart would sign one and mail it back to the bank and the money would then be deposited in his account.

"Well, Mr. Hart. Thank you for doing business with U.A.B."

"Hello , ,Secrepool Distribution Center. , ,"

"Mr. Nehring, each telephone number is associated with a different mailing priority. Your monthly bill is based on the distribution of use of the different numbers. For example, if you want messages processed and mailed immediately, it will cost you more than if there is no rush on the materials."

Johnny entered the kitchen.

His mother leaned over him and felt his warm forehead. "Hmmm. Better not go to school to today."

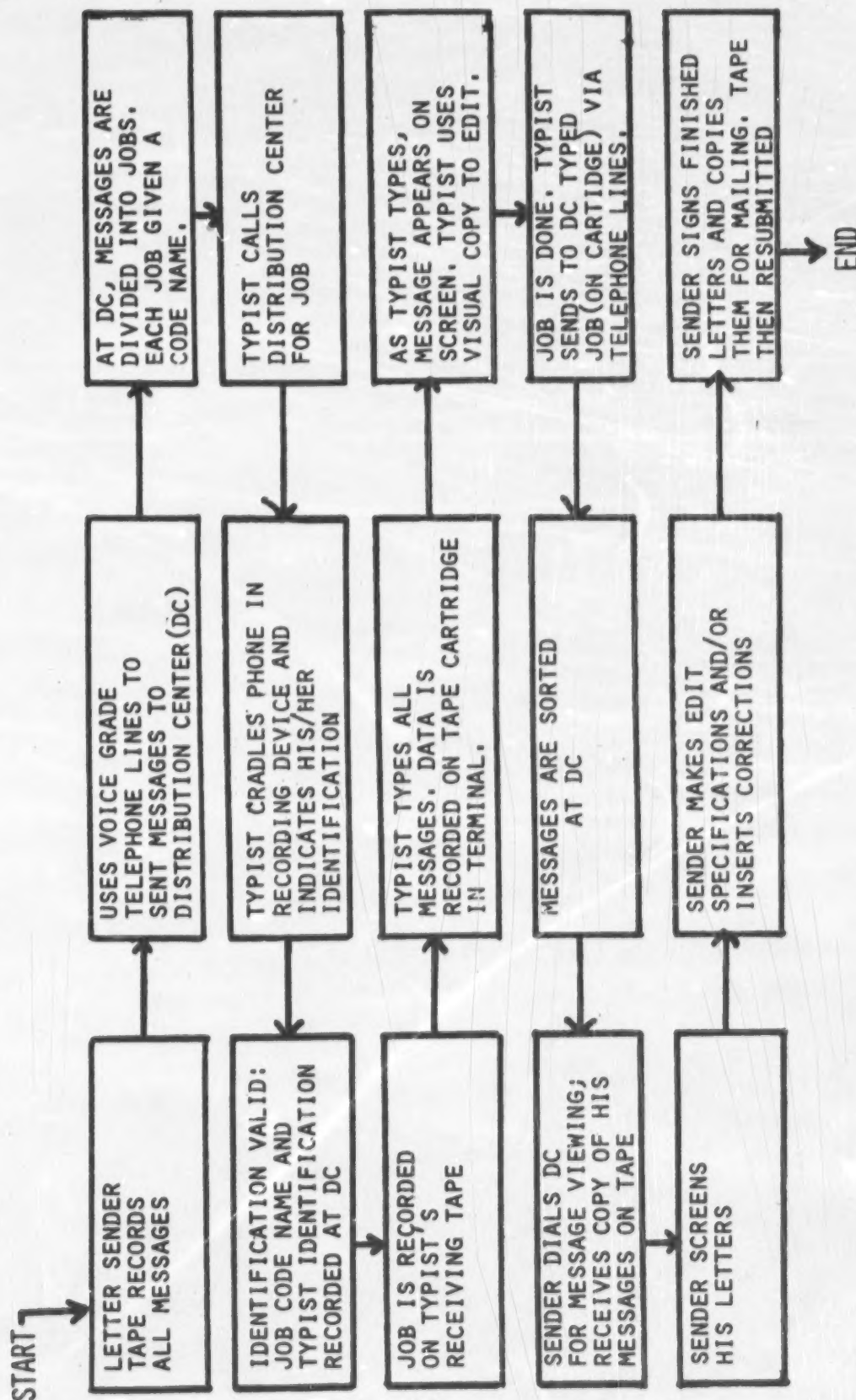
Putting on the headset, she began typing the first letter. As she typed, the message appeared on a screen resting above the keyboard. The letter done, she proofread it and then pressed the FILE key of her keyboard. The letter disappeared, its contents recorded on the terminal's tape cartridge.

It was 8 A.M. and Nehring reached the office early. He went to his phone and dialed a Secrepool number. After identifying

himself, he turned on his recorder and placed the phone head in place. Copies of his typed letters were taped. He placed the cartridge in his terminal. Turning on the terminal, a letter filled the screen. He read it through and picked up an electronic pencil. He inserted his signature and pressed the MAIL key. A new letter filled the screen.

SECREPOOL SYSTEM

PROCESSING NEW MESSAGES



APPENDIX III
IITV Survey (Collins)

USC INTERACTIVE INSTRUCTIONAL TELEVISION PROGRAM

Questionnaire for Students at Regional Classrooms

1. How important to you is the talkback feature of the Instructional Television System?

Extremely important	13
Somewhat important	16
Neither important or important	2
Somewhat unimportant	2
Extremely unimportant	0

2. How important do you think color picture is to the Instructional Television System?

Extremely unimportant	12
Somewhat unimportant	10
Neither important or unimportant	10
Somewhat important	3
Extremely important	0

3. In the future we hope to video tape television classes for replay for students at the regional classrooms who miss them because of job emergencies. How important do you think this aspect of the television program is?

Extremely important	17
Somewhat important	17
Neither important or important	0
Somewhat unimportant	0
Extremely unimportant	0

4. How important is it to you to occasionally be able to see the faces of students in the televised class who are attending on campus?

Extremely unimportant	9
Somewhat unimportant	9
Neither important or unimportant	11
Somewhat important	5
Extremely important	0

If you are not taking your Instructional Television courses for continuing education purposes, skip to Question 7.

5. After being inactive for some time insofar as academic pursuits, did the availability of the Instructional Television Program result in your taking a more aggressive attitude toward continuing education?

No	4
Yes	20

6. If YES, to what do you attribute this new attitude?
(one answer only)

18 Easier to take courses that I need.
0 Because I like the novelty of Instructional Television.
1 My employer brought the program to my attention.
0 Other (please specify) _____

7. If you could make a single improvement in the Instructional Television Program -- technical, educational or administrative -- what would you suggest? see p. 174
- _____
- _____
- _____

8. Do you feel that when you take your class over television, you are missing something of importance by not going to the campus?

No 16
 Yes 13

If NO, skip to Question 10.

9. If YES, rank the three most important aspects of campus education you feel you are missing. (1= most important, 2 = second most important, 3 = third most important)

_____ Personal contact with the instructor. (-#1, 4-#2, 3-#3)
 _____ Contact with other students in your class. (-1#, 5-#2, 4-#3)
0 Contact with other students on campus not in your class.
 _____ Possibility of staying after class to ask questions. (5-#1, 6-#2, 5-#3)
 _____ Exposure to the campus "atmosphere." (1-#2, 1-#3)
 _____ Greater awareness of other campus activities. (1-#3)
 _____ Access to library. (3-#2, 2-#3)
 _____ Other (please specify) 1-#3 access to computer facilities

10. Is the fact that you are watching a live class rather than a delayed tape important?

Extremely important 8
 Somewhat important 16
 Neither important or unimportant 5
 Somewhat unimportant 0
 Extremely unimportant 3

11. Enrollment in an Instructional Television course for credit costs more than if the course is taken on campus. If you had to pay this surcharge personally, what is the most you would be willing to pay?

8 50% more than the cost of driving your car.
15 The cost of driving your car.
3 Half the cost of driving your car.
4 Nothing additional.

12. What aspects of traveling to campus were most important in encouraging you to take the course over television? Please rank order the three most important aspects. (1 = most important, 2 = second most important, 3 = third most important)

 Dislike of driving. (2-#1, 1-#2, 1-#3)
 Traffic conditions (1-#1, 9-#2, 6-#3)
 Parking problems on campus. (1-#1, 6-#2, 7-#3)
 The cost of driving. (5-#1, 6-#2, 7-#3)
 Other (please specify) Time saved (20-#1, 1-#2)

13. Check the one that applies.

12 Because of the availability of television my commuting to the campus has been largely eliminated this semester.
15 Without the television I would not be taking courses.
0 Because of the availability of television I have eliminated commuting to another school to take a comparable course.
4 None of the above applies.

14. If the regional classroom were half as far from the campus as it is, would you choose to go there and take courses over television or to drive to the campus?

Take over television 15
 Drive to campus 15

15. If there were a modern high speed rapid transit vehicle (bus, train) that could take you directly from your company to the campus, would you still take your courses at the regional classroom?

Yes 20
 No 19

16. If it were vital to you to take a course that was being televised, would you choose to commute to the campus, rather than go to the regional classroom, if the campus were

23 A 10-minute drive away from your company.
9 A 10-minute walk away.
7 A 5-minute drive away.
10 A 5-minute walk away.
3 Would continue television program.

17. From the following, rank the three most important reasons leading to your decision to take courses via television. (1 = most important, 2 = second most important, 3 = third most important)

___ Less chance of a traffic accident. (0-#1, 3-#2, 6-#3)
 ___ Less chance of becoming a victim of crime in the streets. (1-#1, 0-#2, 3-#3)
 ___ Less wear and tear on your car. (3-#1, 11-#2, 11-#3)
 ___ Less disruption of your family life. (6-#1, 4-#2, 3-#3)
 ___ Less time lost from work. (22-#1, 5-#2, 1-#3)
 ___ Other (please specify) (2-#1, 0-#2, 1-#3) Time save commuting,
1 -#2, #3 - close to home, 1-#3 taking classes, 2-#3 convenience

18. How far do you commute (one way) in coming to the regional classroom?

2-0 miles, 3-½ mile, 7-1½ miles, 2-2 miles, 5-3 miles, ___ miles
 4-5 miles, 2-6 miles, 1-7 miles, 1-8 miles

19. Do you think your attitude toward the Instructional Television Program will become more positive in the face of energy crisis?

Extremely more	<u>7</u>
Somewhat more	<u>20</u>
Neither more or less	<u>6</u>
Somewhat less	<u>0</u>
Extremely less	<u>0</u>

20. Have you taken courses at the regional classroom as a

24 Regular student.
4 Non-Degree Option (NDO) student.
7 Auditor.

Question #7: Improvement on TV

Offer more advanced degree courses on TV
 Technical improved reception and talkback
 Arrange picture so that the material written by the Prof. would be visible for a longer time, as it would be on the blackboard of a classroom
 Train the cameraman to provide some variety in the coverage of the lecture
 The camera work has been very poor, needs much improvement
 Improve talkback. Light to raise hand without interfering with sound on monitor or opening channel to talkback.
 Eliminate surcharge

More classes on TV

More peripheral vision of lens to enable you to see greater % of chalkboard, etc.

Improve the technical aspects - improve picture and talkback feature

Have notes of lecture passed out everytime or on request in case student has missed class(es). Pass out formal homework solutions

Mainly, the TV reception should be improved. Also, I would hope that as many CS courses as possible will be televised to minimize trips to campus. I think it's a good program. It would be nice if it didn't cost so much extra for TV

Offer more classes

Improve talkback audio quality at the classroom. Use the value compression (automatic volume control) is desirable. Eliminate microphone keying transient ("pop").

Technical: talkback was inoperative at woodland hills for several seminars. The ability to hear questions asked by student in the campus classroom.

Many times the questions they asked were inaudible.

Improve picture and talkback quality

Clearer video signal

Make the talkback system work-- usually all you hear is static

Perhaps a terminal link to the University Computer Center on campus

Improve talkback

The program to write larger on the board and attempt to keep things together so that the operator isn't moving back and forth with the camera.

The instructors voice came over perfectly. But when students in the classroom asked a question (and pushed the button), they could not be understood.